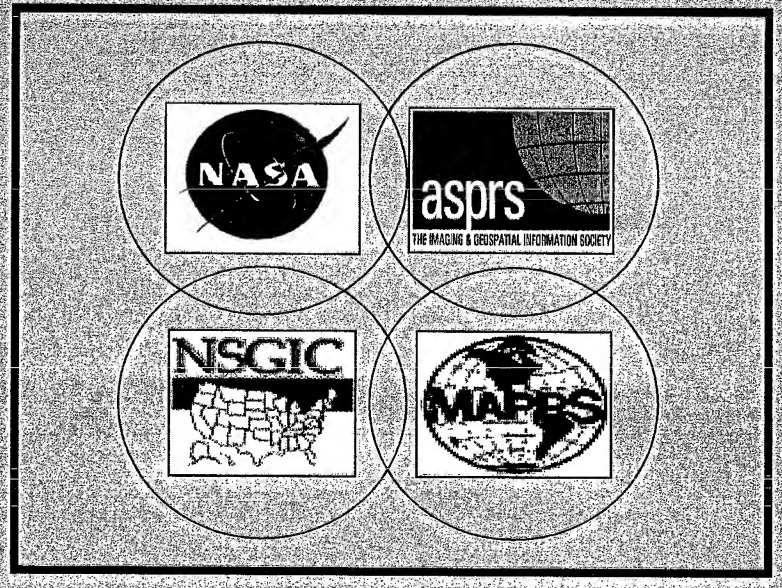
Highlights

The 10-Year Remote Sensing Industry Analysis



March 21, 2002

Background

In August 1999, ASPRS and NASA's Commercial Remote Sensing Program (CRSP) entered into a 5-year Space Act Agreement (SAA), combining resources and expertise to:

- Baseline the Remote Sensing Industry (RSI)
- Develop a 10-Year RSI market forecast
- Provide improved information for decision makers
- Develop attendant processes

Analysis Plan

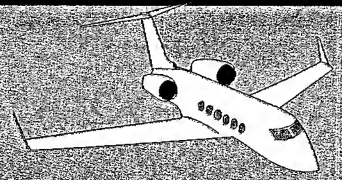
Phase I Characterization and Baseline Forecast of the Industry (Dec 2000)

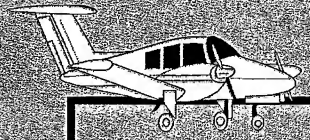
Phase II Characterization of Customers/Users and Determination of Their Needs/Requirements (April 2002)

Phase III Validate I and II (Dec 2003) Technology Assessment

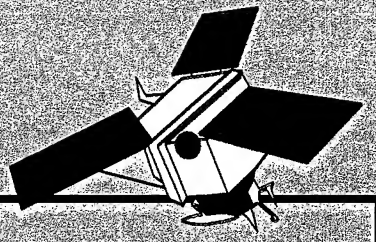
Phase IV Market Forecast (Dec 2004)

Remote Sensing Industry Definition





Platforms & Sensors



Phase I

Data Collection

Data Processing

Support Elements

- Hardware
- Software
- Etc.

Industry Intermediaries

- VARs
- Consultants
- Etc.

Business Segments

End-User

Phase II

Analysis Participants

- NASA*
- NOAA*
- USGS*

- ASPRS*
- MAPPS*
- NSGIC*

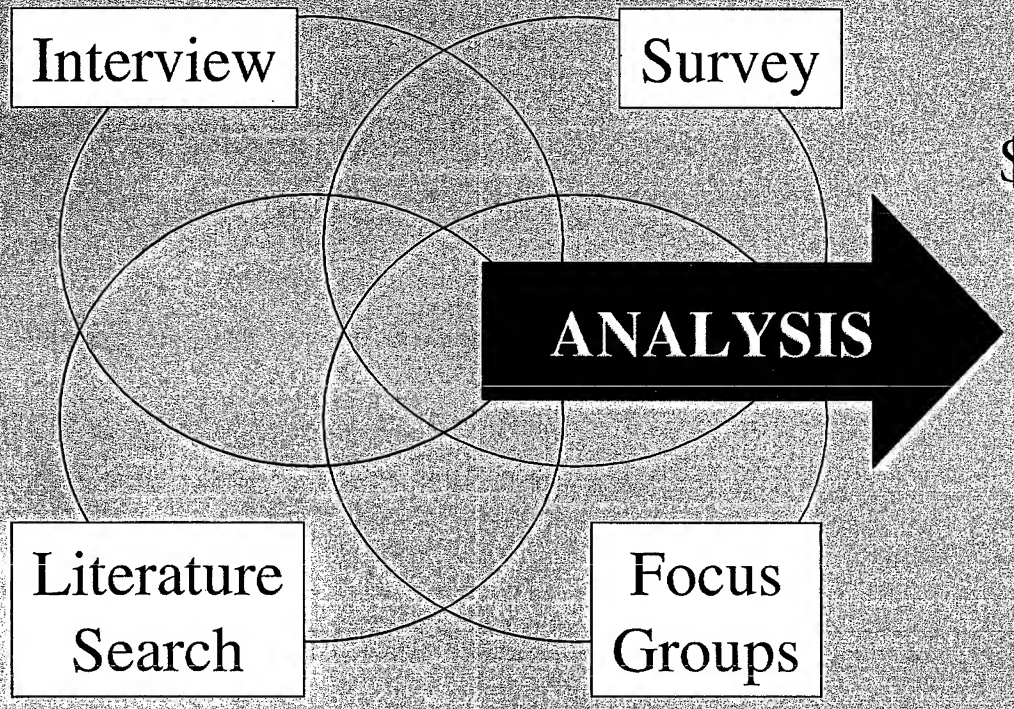
- American Forests
- Autometrics
- Eaglescan
- EarthData
- Geomatics
- Kodak
- Landcare Avn.
- Leading Edge
- Lockheed Martin
- PAR
- Pictometry
- RAND
- Spencer-Gross
- SPOT
- Space Imaging

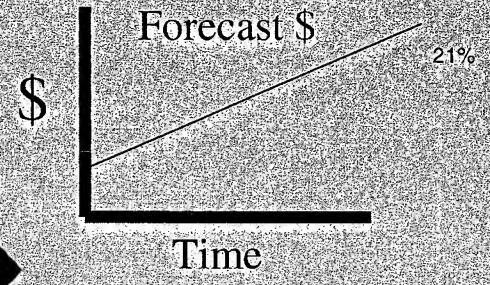
- RIT
- University of Arizona*
- University of Missouri*
- University of Southern Mississippi*
- University of Utah*

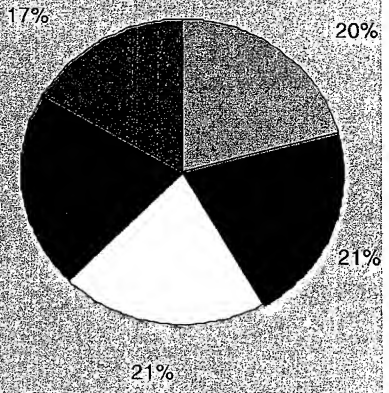
Analysis by the Industry For the Industry

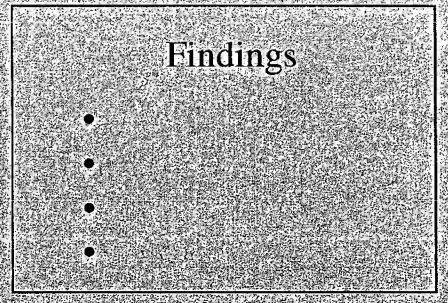
(Not by an outside agent for profit)

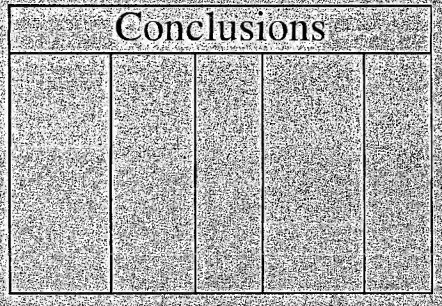
Analysis Process









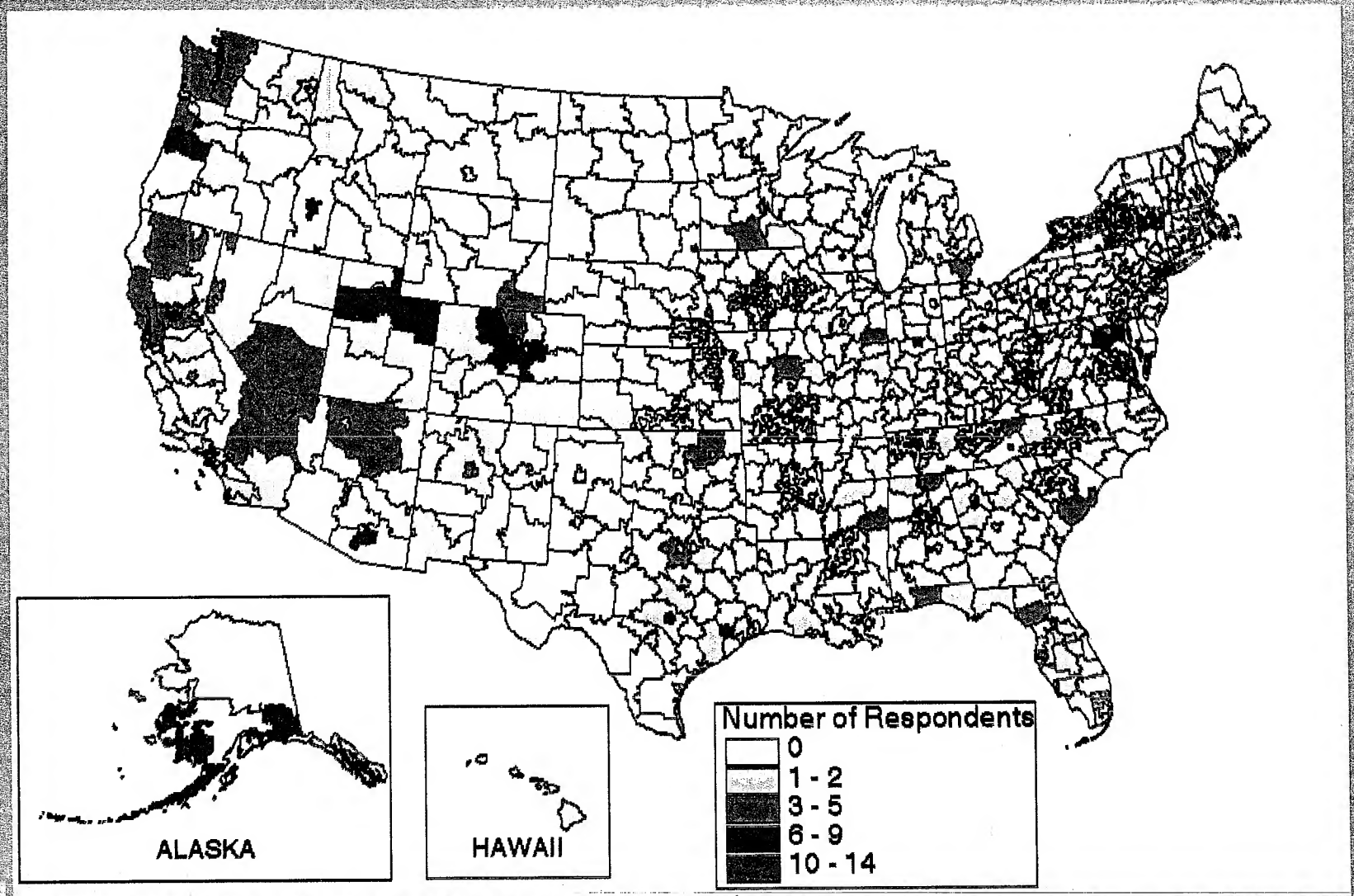


Assumption: A Representative Sample

- ✓ **About 1,450 industry professionals**
  - **Phase I**
    - → 36 Interviews (commercial); 437 Survey Responses; Closed Envelope (43)
  - **Phase II**
    - → 134 Interviews; 750 Surveys;4 Focus Groups (@15 people per); Closed Envelope (42)
- ✓ **Geographic Dispersion**
- ✓ **Participation**
  - **Professional Assns. (ASPRS, MAPPS, NSGIC), Government Agencies, Private Companies**
- ✓ **Sector Coverage**
  - **Academic, Commercial, and Government**

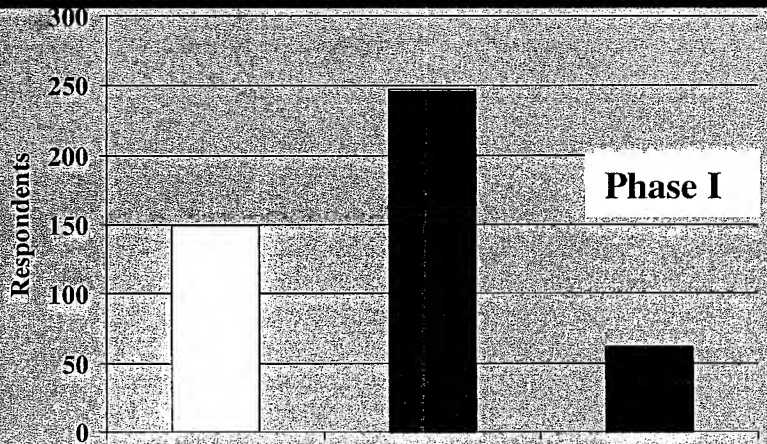
Based on Phase II Survey Responses

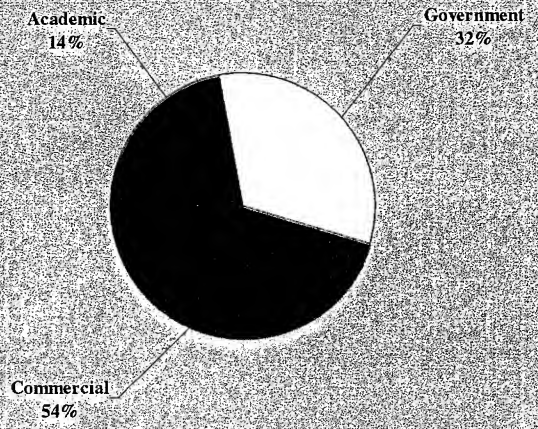
Respondent Zip Code Distribution All Sectors

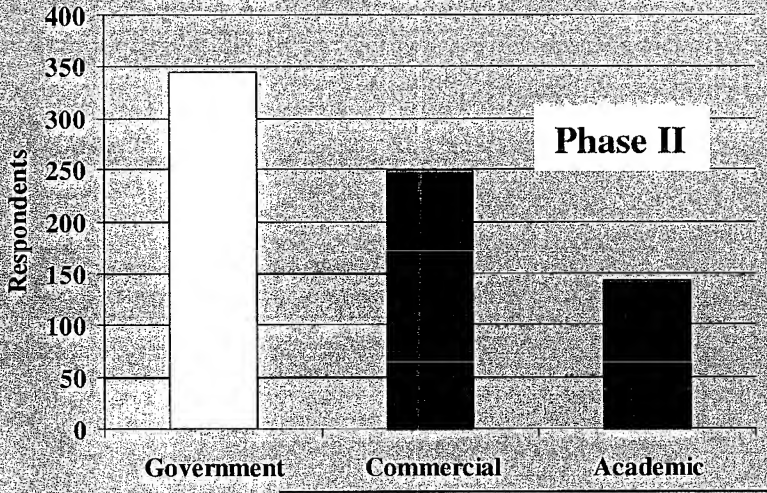


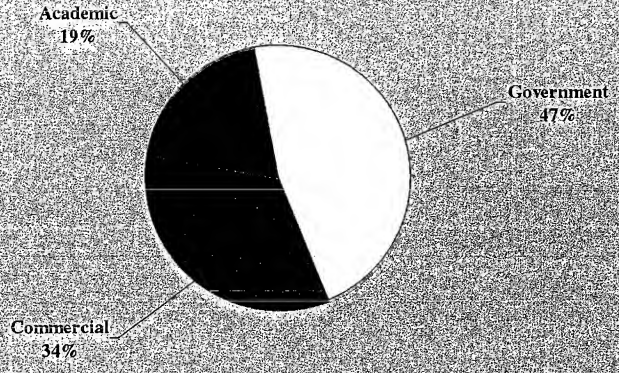
Based on Phase II Survey Responses

Respondents by Industry Sector









We believe:

- **The difference is in the sampling technique used**
- **Phase II is more representative of the Industry**

Based on Phase II Survey 735 Responses

Primary Job Titles by Sector

ACADEMIA	
Academic Administrator	4
Professor	38
Associate Professor	16
Assistant Professor	22
Instructor	5
Adjunct Faculty Member	1
Laboratory Director	8
Research Staff	28
Student	14

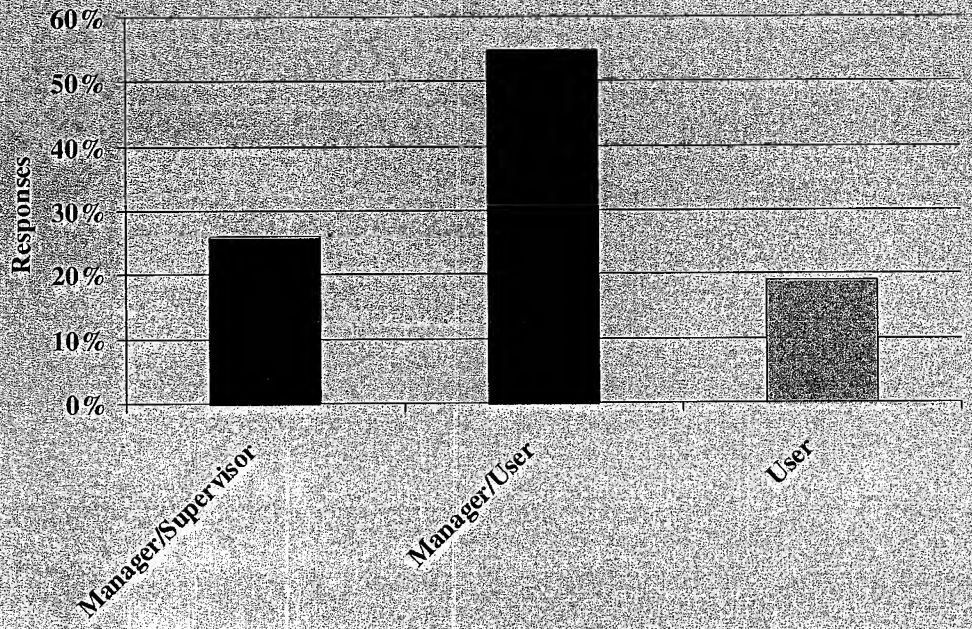
COMMERCIAL	
Owner	42
President	13
Top Level Manager	32
Senior Manager	26
Sales Manager	5
R&D Manager	8
Marketing Manager	2
Product Manager	12
Manager	21
Analyst	42
Engineer	22
Technician	7

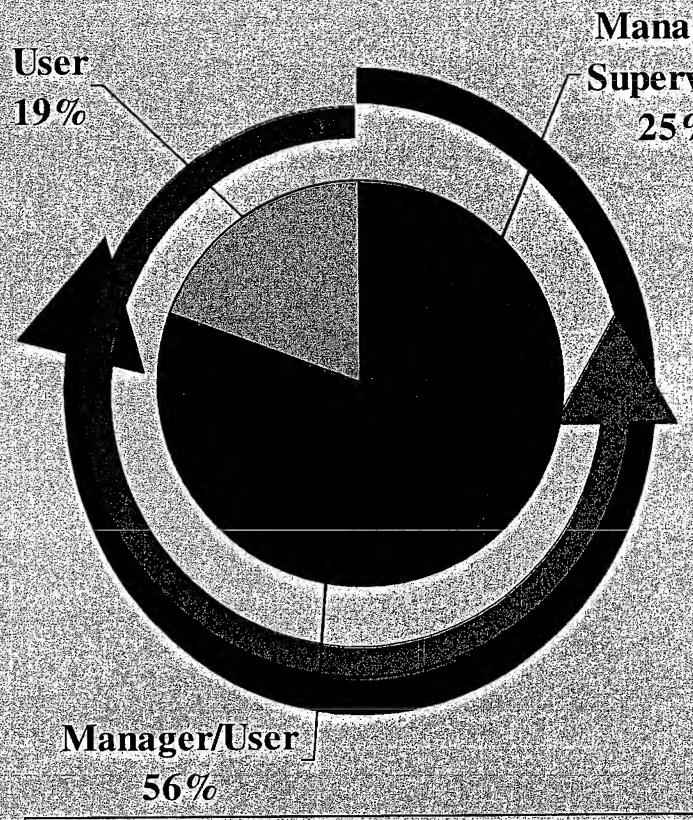
GOVERNMENT	
Executive Director/Senior Manager	82
Research/Scientist	50
Program Staff	39
Professional Technical Staff	131
Technician	17

- **A balanced cross-section of jobs/tasks in the industry**

Based on Phase II Survey Responses

Manager and User Perspective





- **MANAGER/SUPERVISOR: a person who can (influence) (spend) (allocate) (authorize) dollars to purchase/acquire remotely sensed data, information and/or software.**

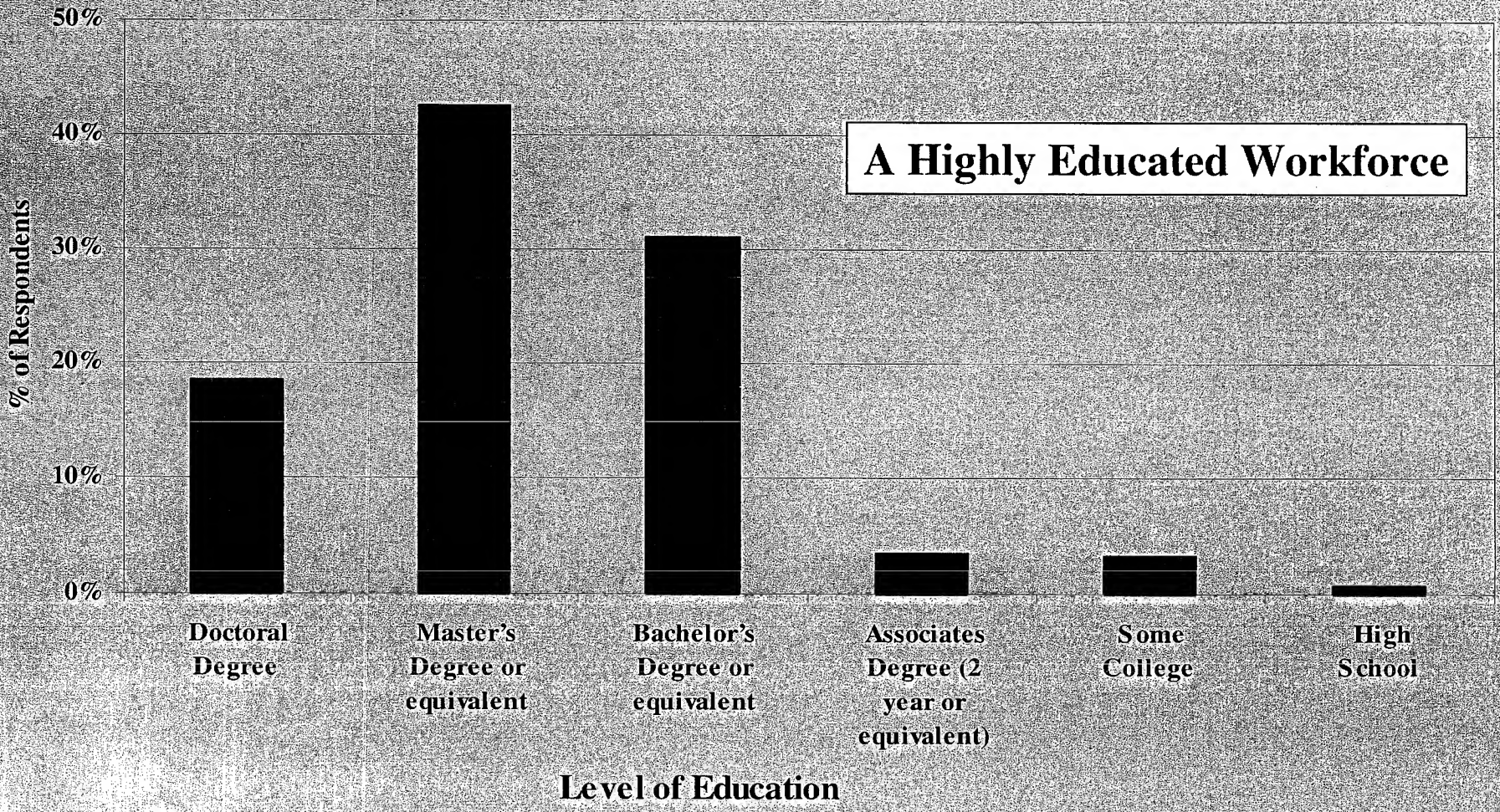
- **MANAGER/USER: a person who can (influence) (spend) (allocate) (authorize) dollars to purchase/acquire remotely sensed data, information and/or software and works with said data, information and/or software.**

- **END-USER: a person whose job would entail working with remotely sensed data, information and/or software.**

- **75% User Group**
- **81% Manager Group**

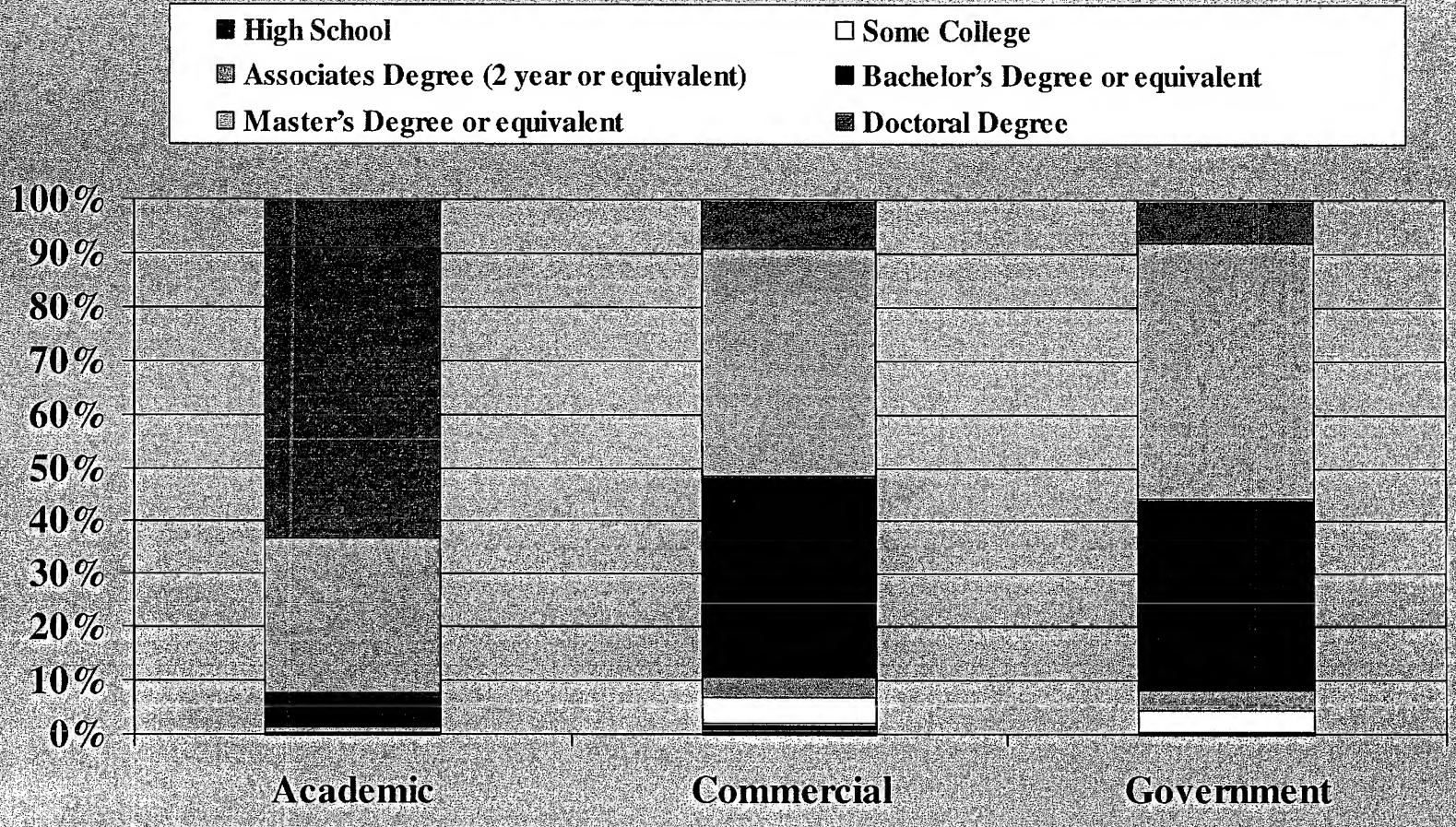
Based on Phase II 735Survey Responses: Manager/Supervisor 189, Manager/User 403, User 143

Level of Education



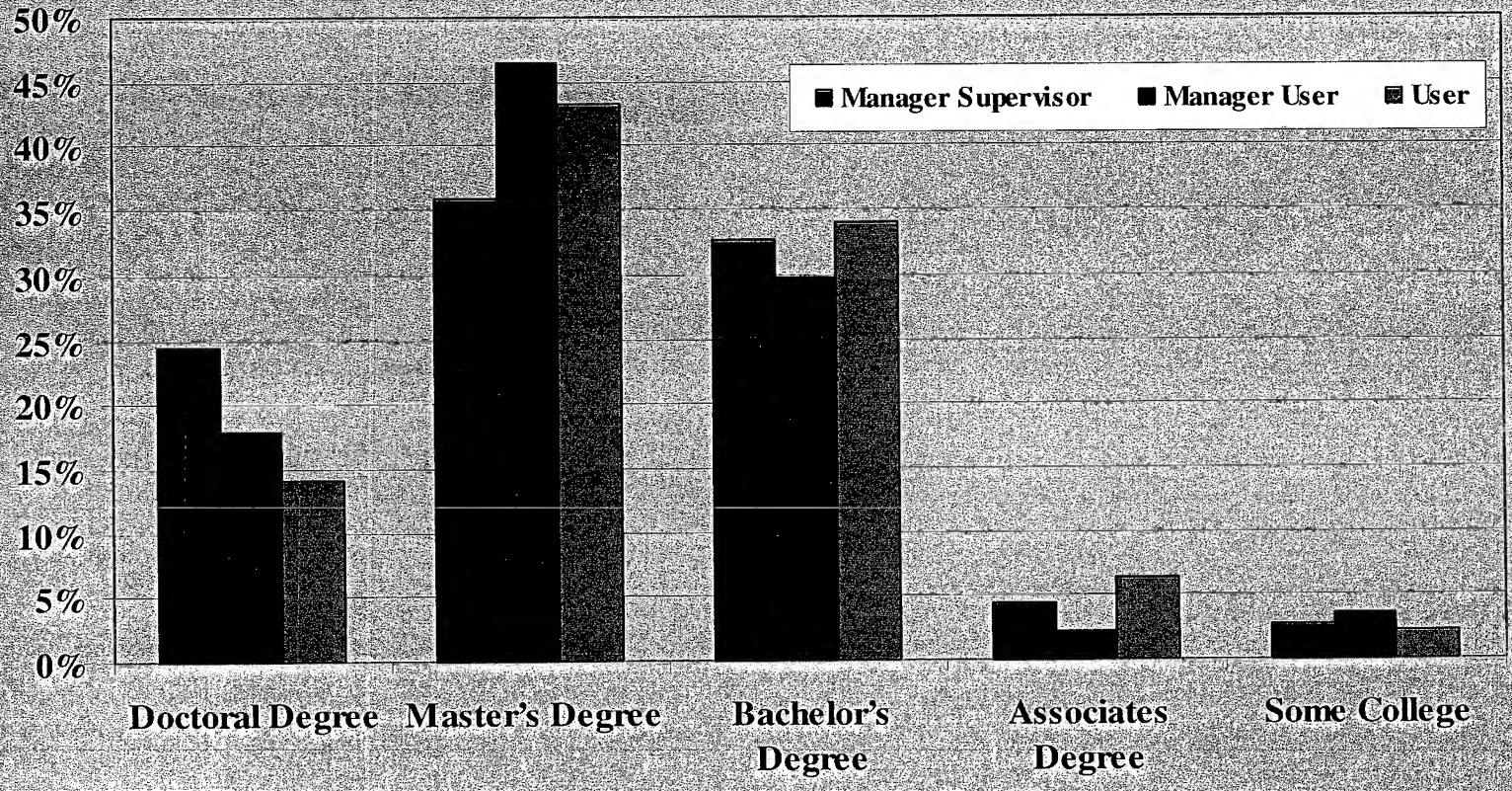
Based on Phase II 731 Survey Responses: Doctoral Degree 136, Master's Degree or equivalent 312, Bachelor's Degree or equivalent 227, Associates Degree (2 year or equivalent) 26, Some College 24, High School 6, Other 0

Level of Education by Sector



- Greater than 90% have a 4-year college degree or better.
- Over 60% have a Masters degree or better.

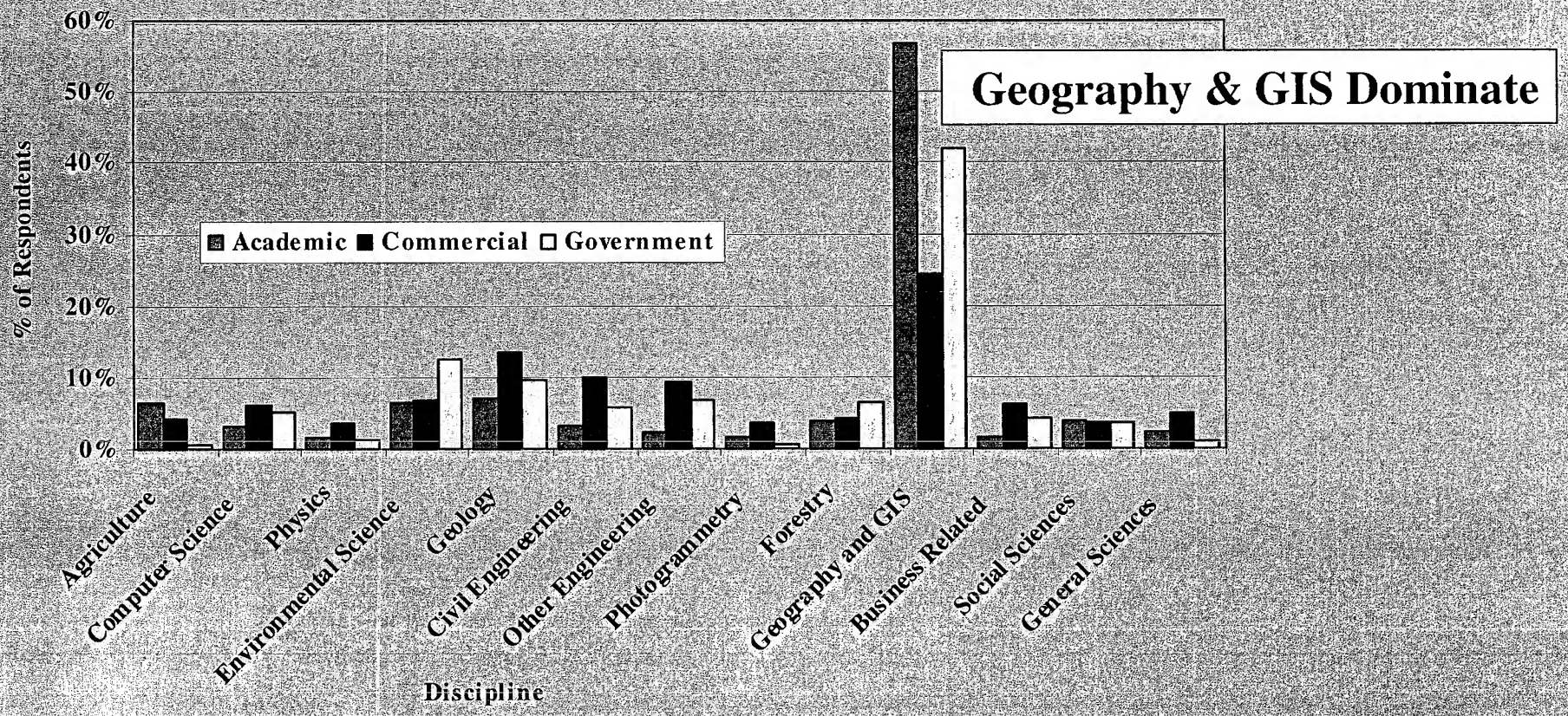
Level of Education: Manager/User



- Overall, there is good Manager-to-User balance in terms of level of education
- Manger Supervisors tend to have Doctoral more frequently
- Manager Users and Users tend to have Masters more frequently

Based on Phase II 721 Survey Responses: Manager/Supervisor 184, Manager/User 396, User 141

Degrees by Discipline by Sector and Manager/User



Geography & GIS Dominate

- The "generalists" in remote sensing are degreed in Geography and GIS and are probably very mobile in the Remote Sensing Industry
- Other disciplines are probably more transportable outside Remote Sensing Industry

Formal Coursework in Remote Sensing

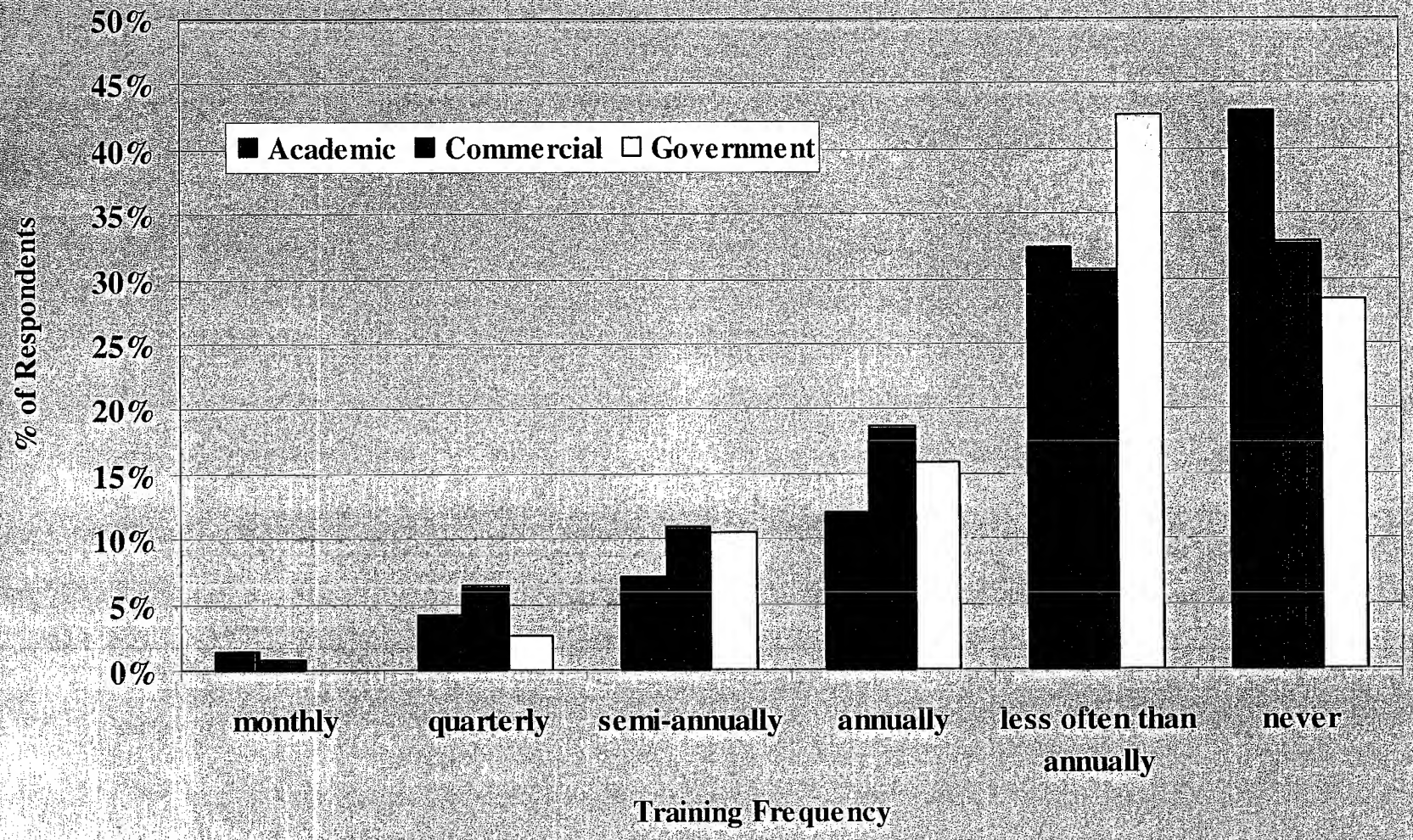
Regardless of discipline, about 60% have had course work related to remote sensing

- **Academic 75%**
- **Commercial slightly less than 50%**
- **Government nearly 60% of the respondents**

The current community of managers/users is both well-educated and generally knowledgeable about remote sensing

Based on Phase II Survey Reponses

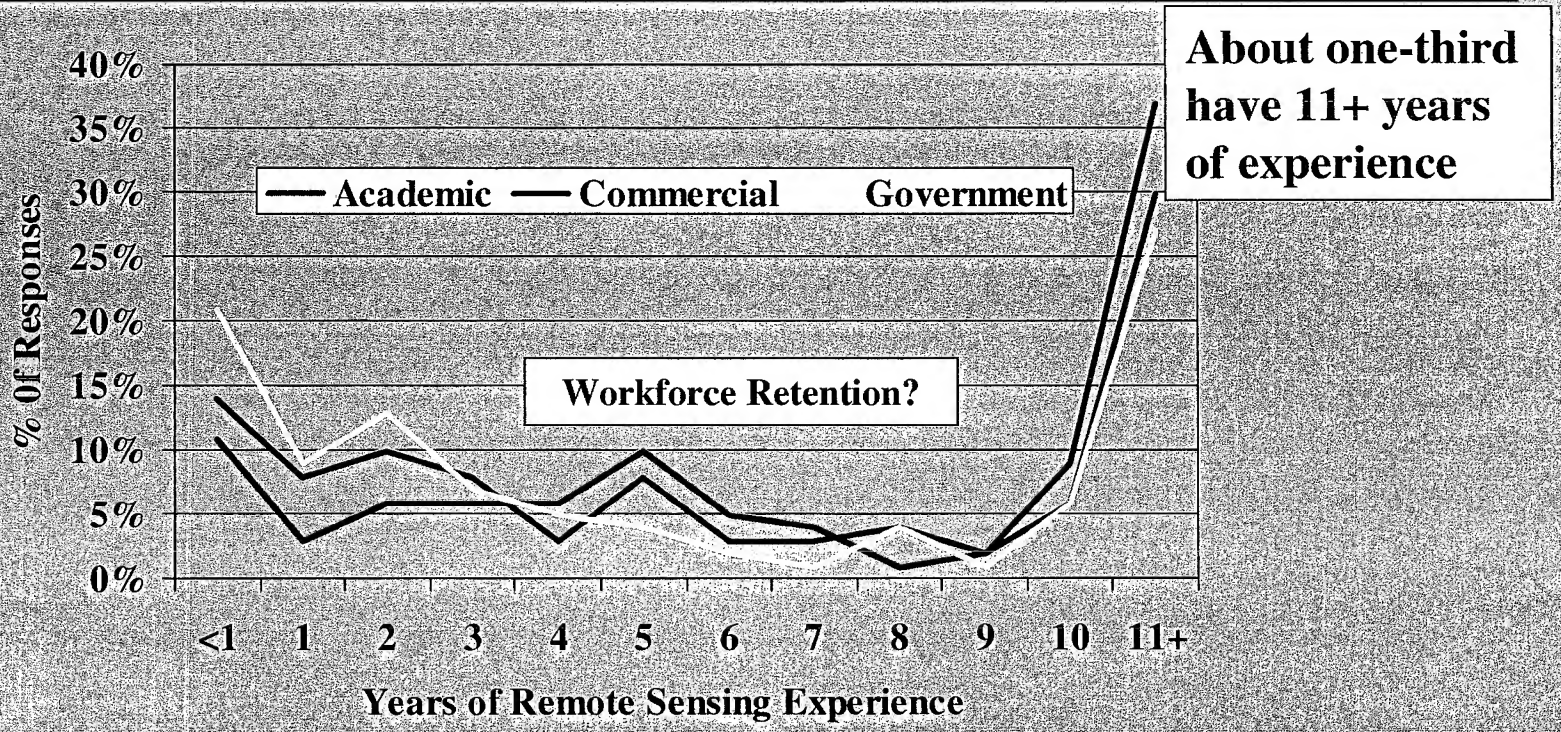
Employer-Sponsored Training by Sector



- Most employers do not have frequent training for employees.

Based on Phase II 734 Survey Responses: Academic 142, Commercial 247, Government 345

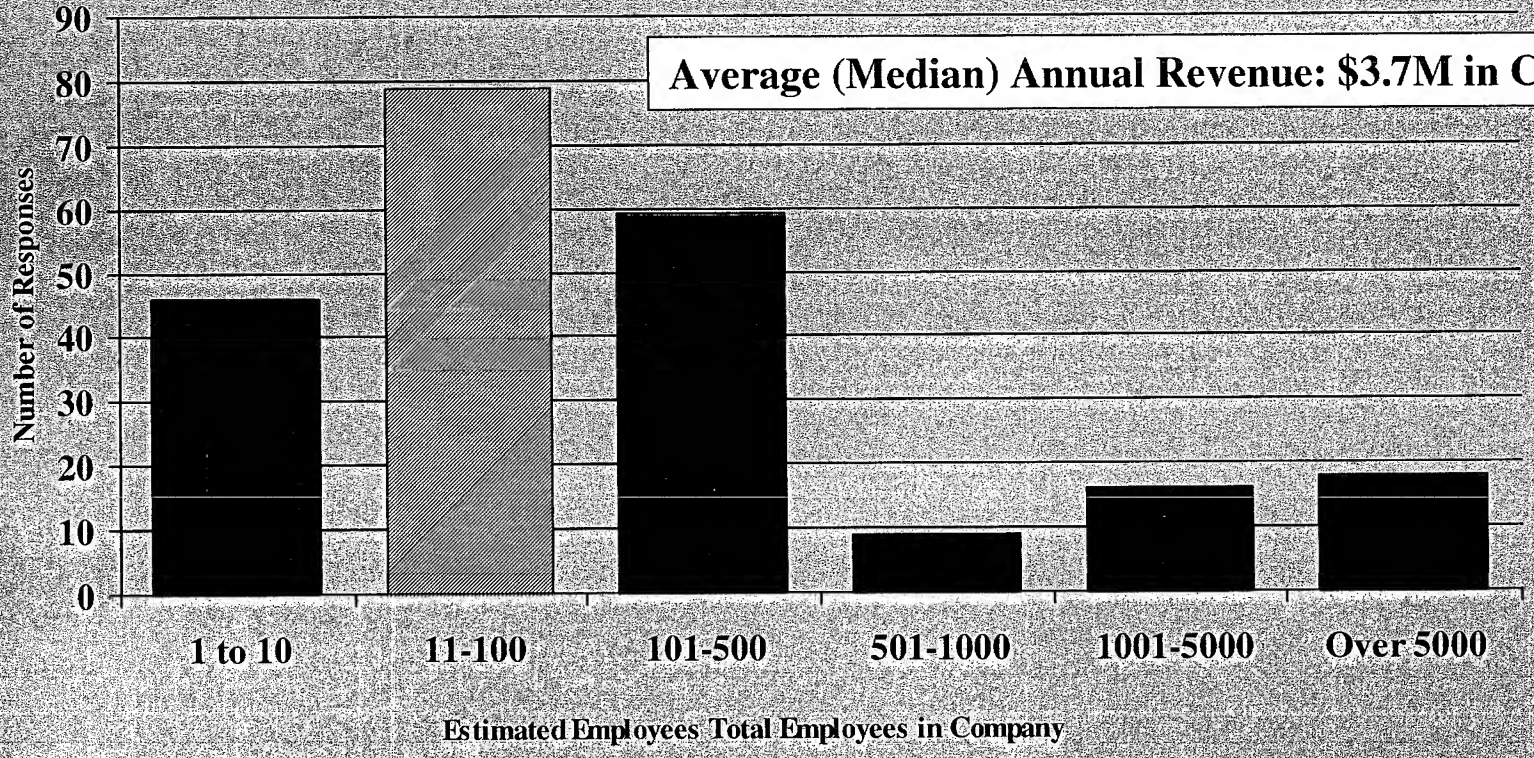
Experience: Remote Sensing Industry



- A bi-modally distributed workforce
- Government has most "entry levels"(>20%) , but least with 10/11+ years of experience (<30%)
- Academia has nearly 40% with 11+ years experience
- Apparently, workforce retention is a key issue

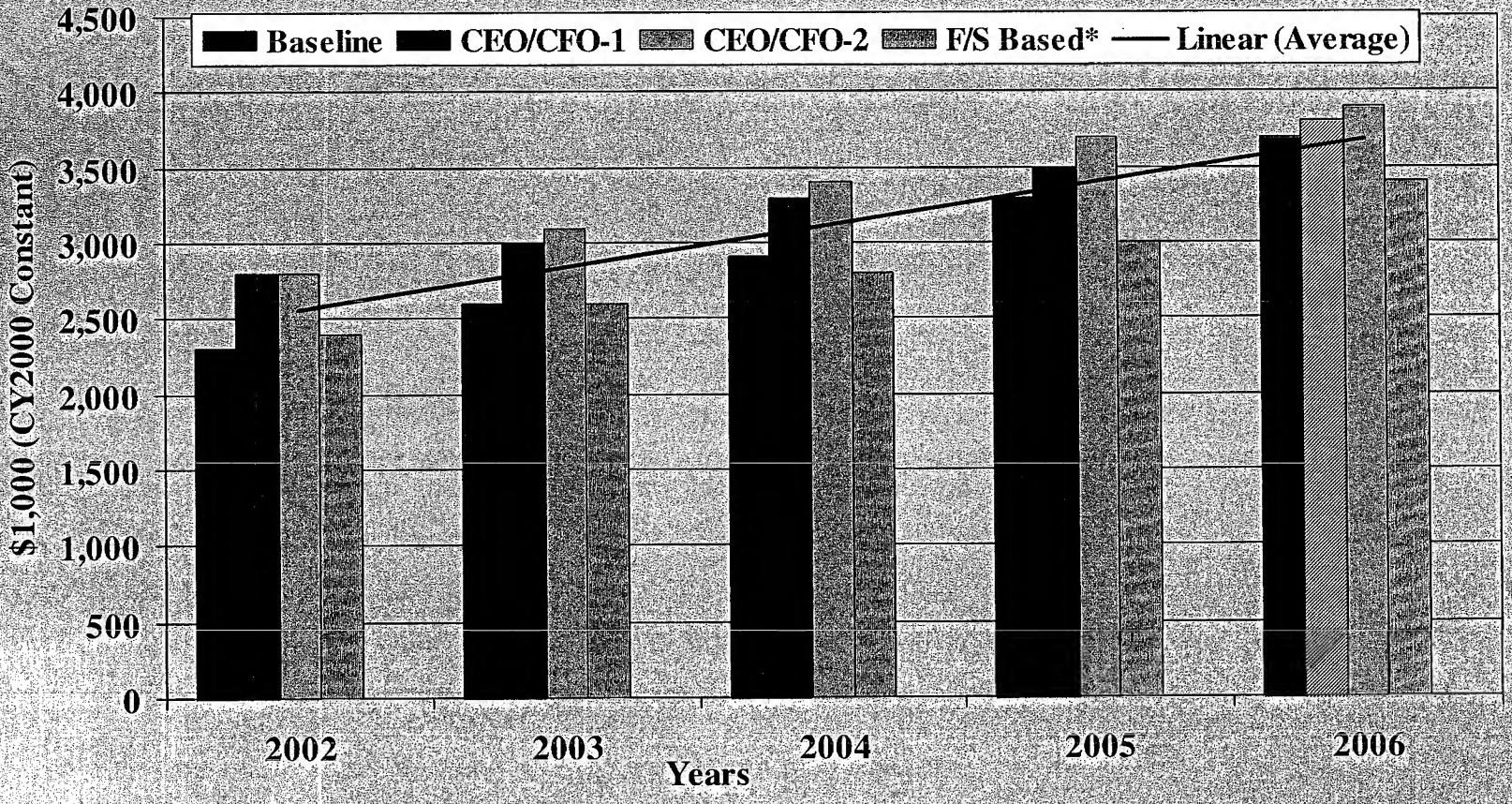
Based on Phase II 734 Survey Responses Academic 142, Commercial 248, Government 344

Commercial Company Size



- ✓ This is a fragmented industry
- ✓ Smaller companies are in the majority
  - About 20% of respondents estimated at 10 or less employees
  - About 55% of respondents estimated at under 100 employees
    - → (% < 50 ?)
  - Over 80% of respondents estimated at under 500 employees

U.S. Sales/Revenues Comparisons

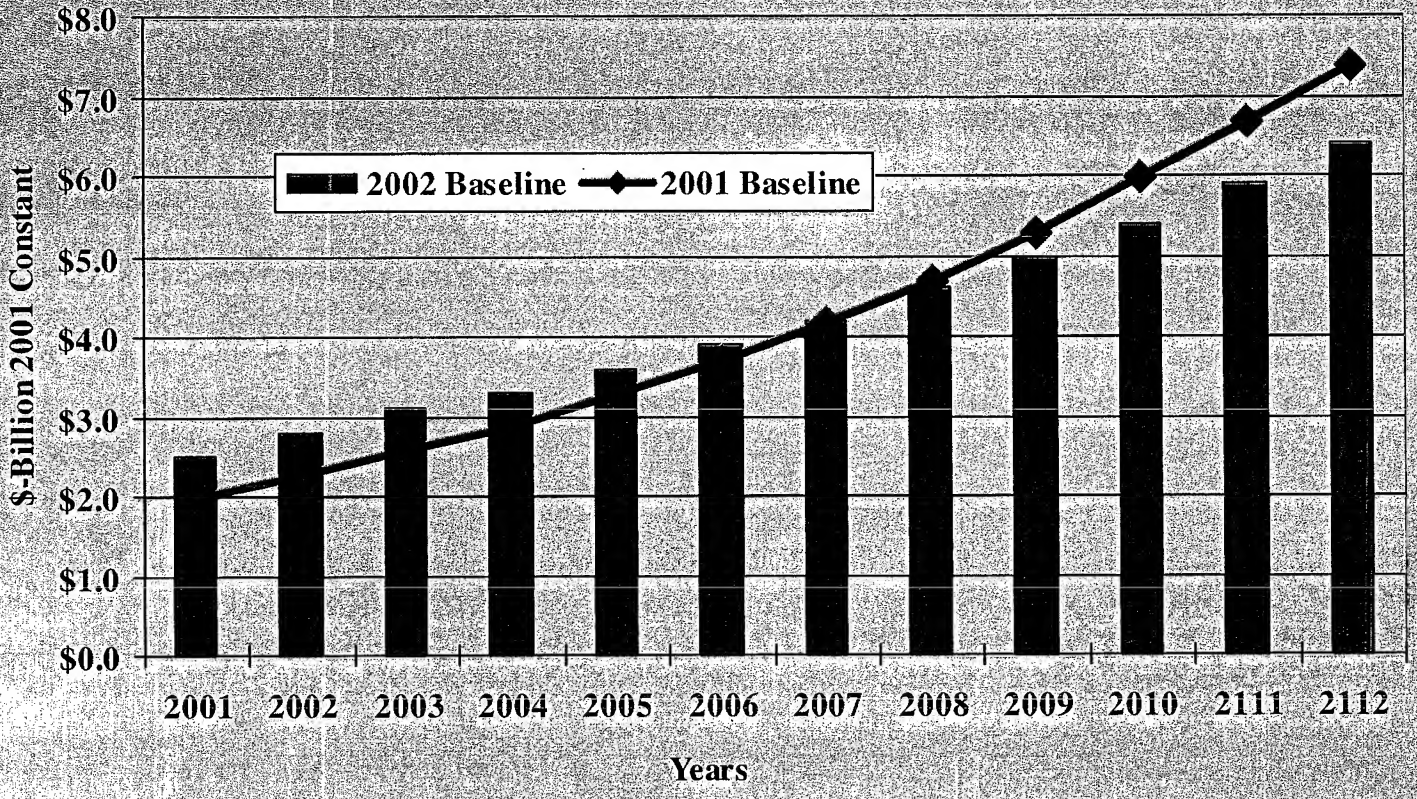


- All are slightly different "counts"
- All are in the same "ballpark"
- *All predict growth (AAG= about 9%)*

*Frost and Sullivan 2001

2002 Baseline Forecast

- Assume best insight comes from CEOs/CFOs and use their Expected Revenues and build revised baseline 2002 accordingly

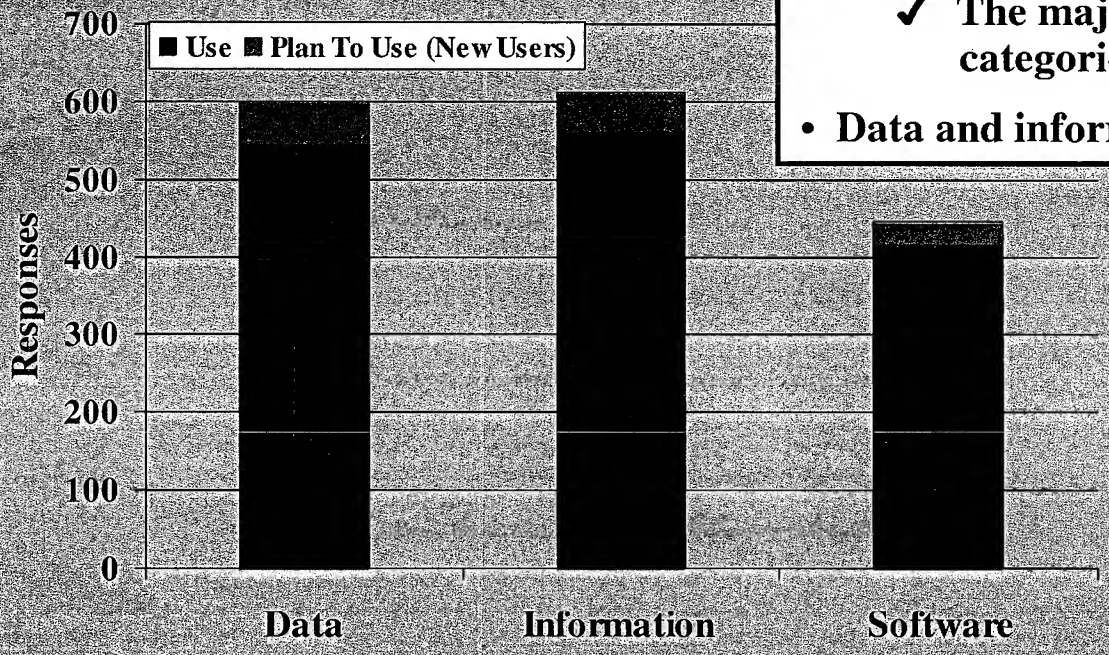


Approach:

1. Average 2001 and 2002 CEO/CFO Expected Revenue estimates. Use to plot 2001-2006
2. Apply AAGR associated with those estimates to forecast 2007-2112

Use/Plan To Use Remote Sensing Data/Information/Software

- >735 Respondents; 1,600 responses
  - ✓ The majority of respondents use at least two categories
- Data and information are used more than software



Suggests more Data/Information Users Considering Market Entry

DIS Use Patterns		
	Using	Planning to Use
Data	73	55
Information	74	19
Software	7	2
Data/Information	97	13
Data/Software	34	7
Information/Software	17	1
DIS	356	19
Totals	658	116

Estimated short-term growth: 9.0%

- Data: 10.0 %
- Information: 9.0 %
- Software: 7.0 %

Based on Phase II Survey Reponses

Analysis of Aerial Market Drivers*

Drivers	Impact			
	Near Term (1-2 yrs.)	Mid Term (3-4 yrs.)	Far Term (5-7 yrs.)	Analysis
Urban Growth	High	High	High	Agree
Decreasing Data Costs	Medium	Medium	High	M, H, H
Demand for High Spatial Resolution	High	Medium	Medium	H, H, M
Data and Software Licensing Requirements	Medium	Medium	High	M, H, H
Aviation Infrastructure	Medium	Medium	Medium	?? 9/11
PC-based Operating Environments	Medium	Medium	Medium	M, H, H
Demand for Newer, Different Data	Low	Medium	Medium	M, M, H

*Frost & Sullivan 2001

Analysis of Aerial Market Restraints*

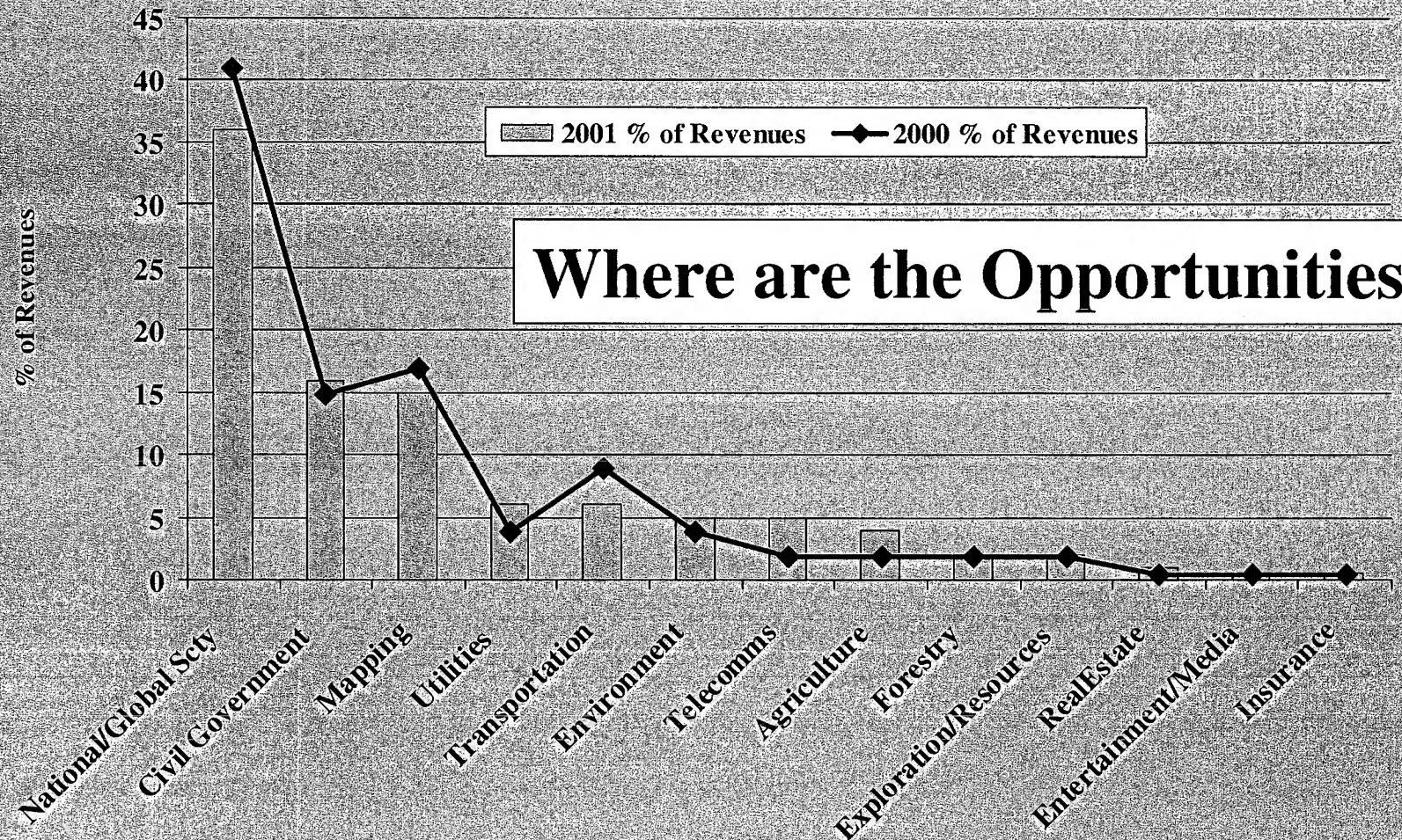
Restraints	Impact			
	Near Term (1-2 yrs.)	Mid Term (3-4 yrs.)	Far Term (5-7 yrs.)	Analysis
Cost of Customized Data	High	High	High	H, H, M
Data Markets Fragmented	High	High	Medium	M, H, H
"Free" USG Mapping Data	Medium	Medium	Medium	H, H, M
Education of User	Medium	Medium	Medium	H, H, M
Time to Deliver Customized Data	Medium	Medium	Low	?? 9/11
Profitability of Emergent Market Unproven	Medium	Low	Low	M, H, H
Correctly Anticipating User Needs	Medium	Low	Low	M, M, H
Slow Growth of Non-USG Users	Medium	Medium	Low	M, L, L
Current Planning Timelines for End-User Adoption Unrealistic	Medium	Medium	Low	Agree
Competition From Space Imagery	Low	Medium	Medium	L, L, M

*Frost & Sullivan 2001

Market Segments

- Agriculture
- Civil Government
- Entertainment/Media
- Environmental
- Exploration & Mining
- Forestry
- Insurance
- Mapping
- Military/Intelligence (National/Global Security)
- Real Estate
- Telecommunications
- Transportation
- Utilities

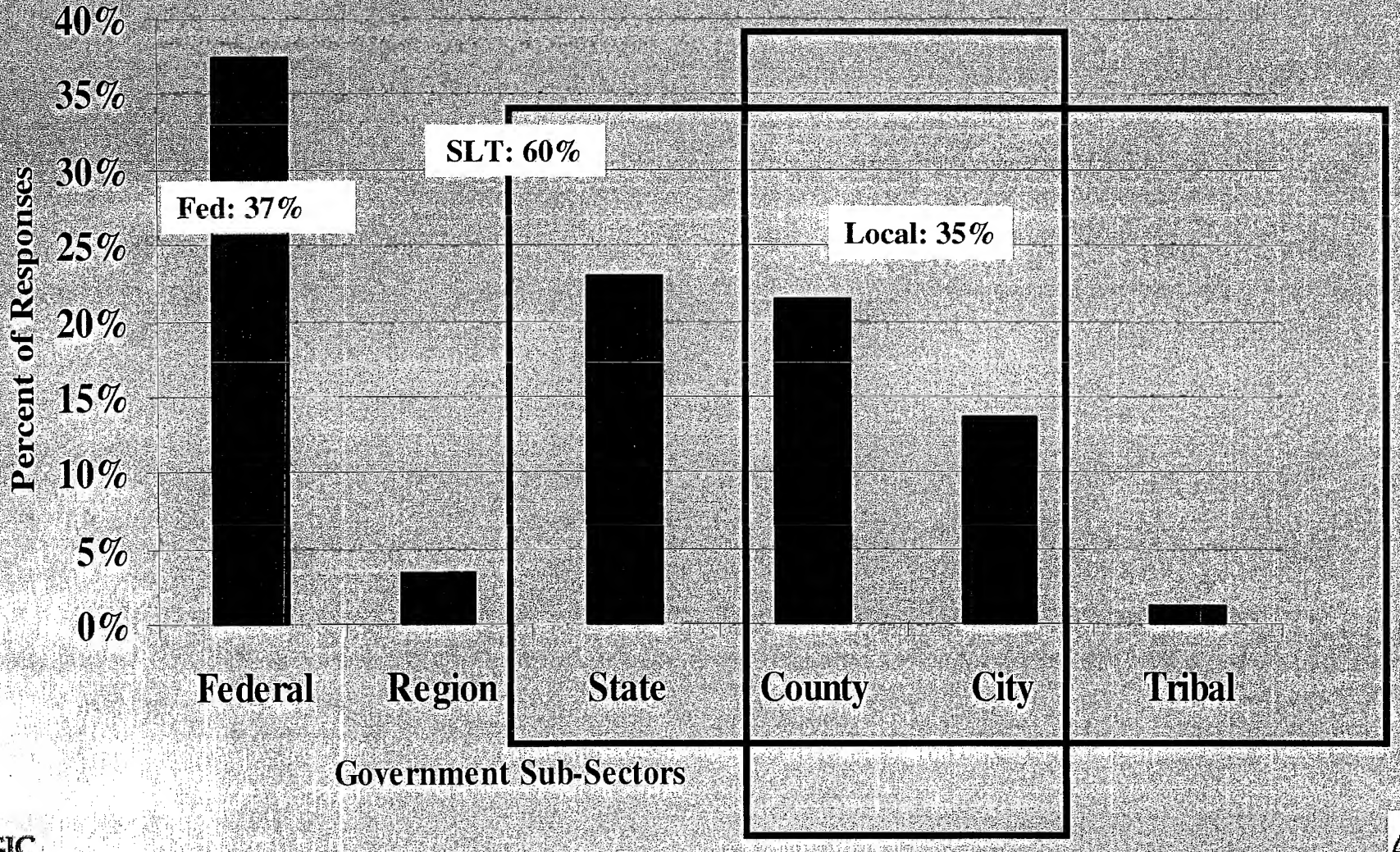
% of Revenues by Market Segment 2000 & 2001



Based on Responses of >40 CEOs/CFOs

(nearly 20% of "Core Companies")

Government Sub-Sectors of Employment



Based on Phase II 344 Survey Responses: Federal 128, State 79, County 74, City 47, Regional 12, Tribal 4

The County* GIS/RS "Environment"

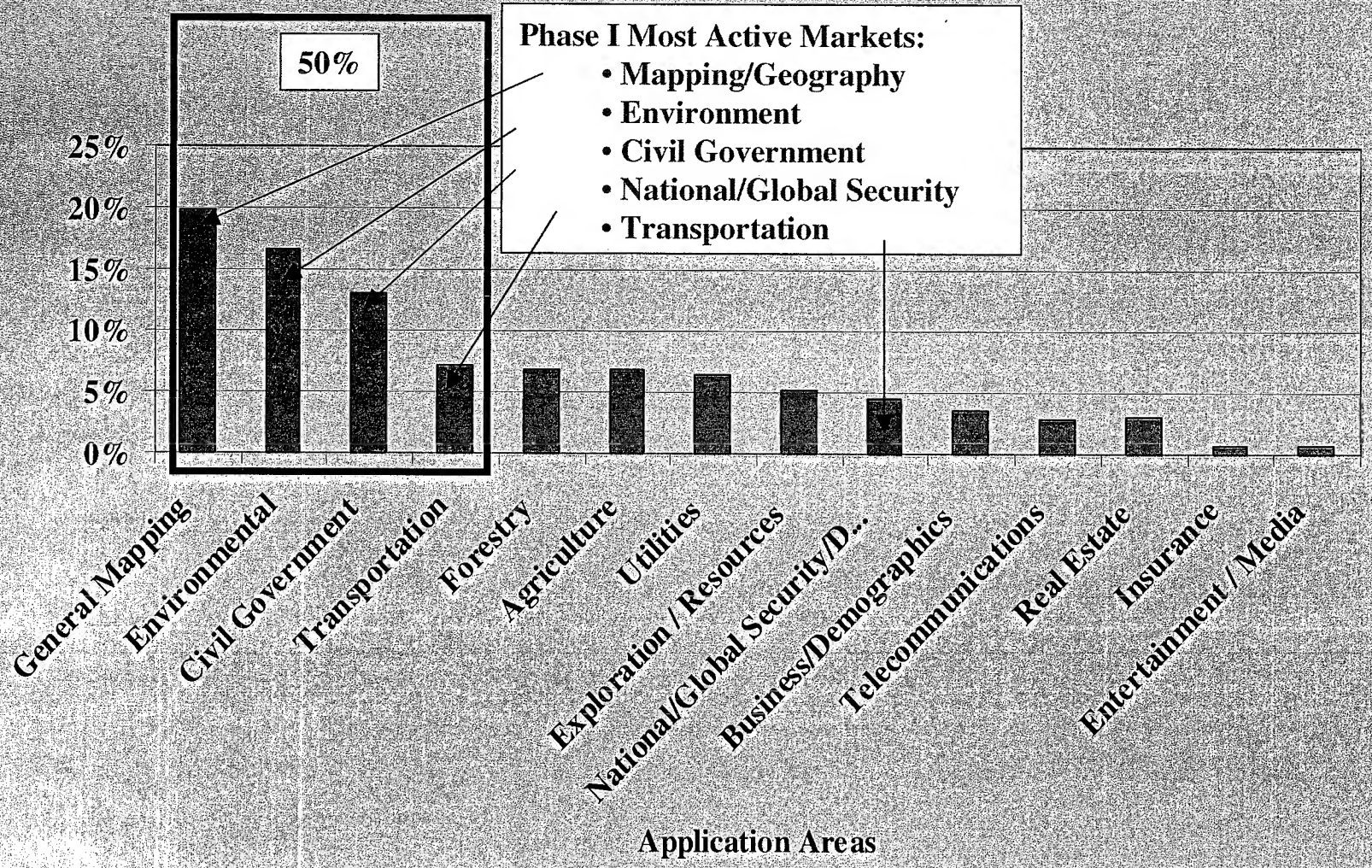
(A Major Potential Customer Group)

- ✓ While not fully aware of the terminology and capabilities of a GIS, most NACo (elected officials) interviewees know it is related to mapping
- ✓ 1998 NACo GIS committee established to educate the NACo membership
- ✓ Current users of GIS are strong advocates
- ✓ Generally, county government GIS databases have a wide range of maturity
  - County capabilities vary from computerless to hi-tech
  - Usually combine aerial photography with existing GIS
- ✓ The contact person at the county level is the GIS Coordinator. This is where the GIS knowledge lies.
  - Resides in various departments, e.g., Planning, Information Technology, County Assessors, County Surveyors, etc.
- ✓ Elected officials must address political as well as GIS issues when making decisions

Based on Phase I Survey Responses

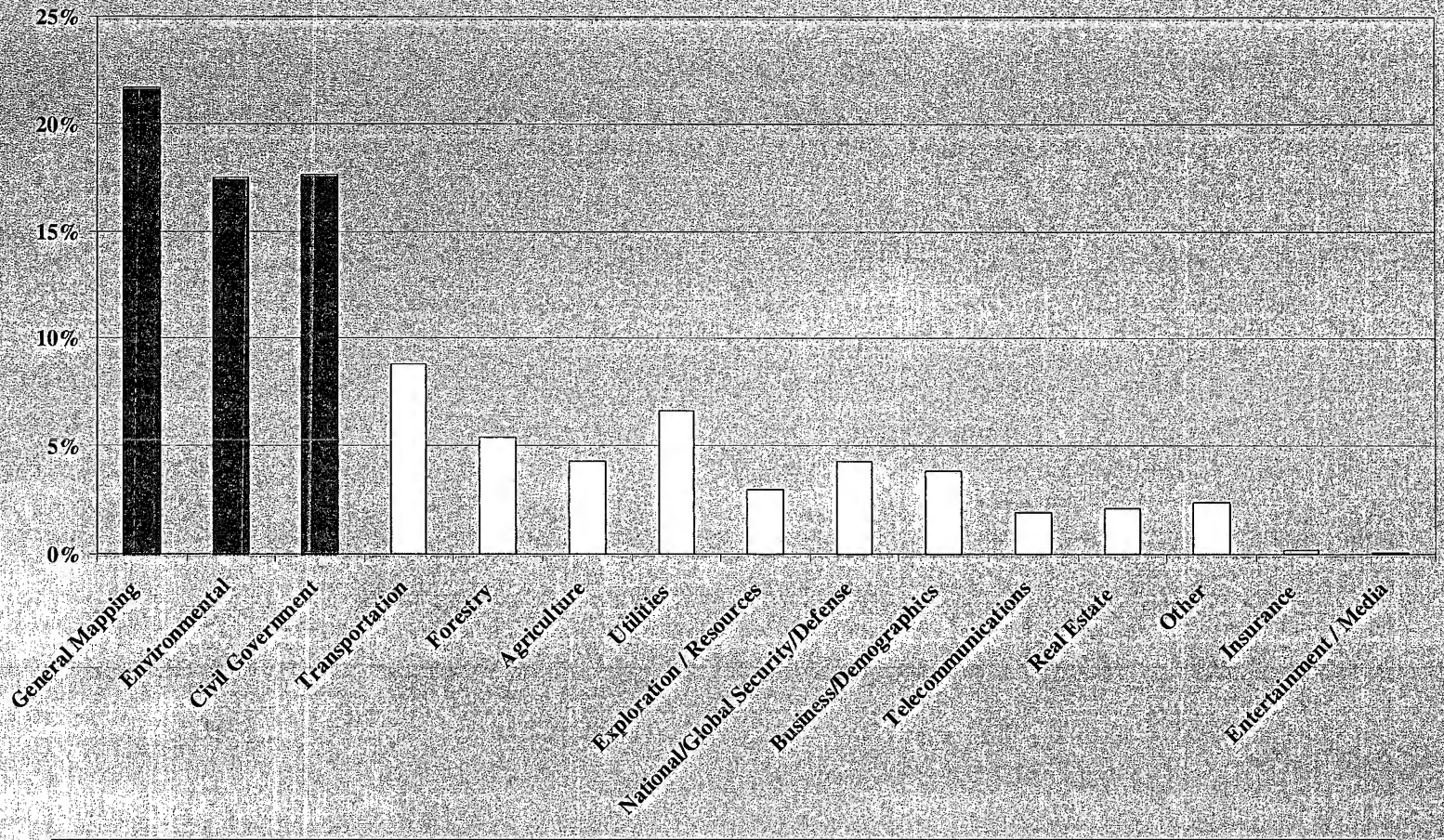
* Per 51 NACo Interviews

Application Areas In Which Respondents Work



Based on Phase II 2440 Survey Reponses

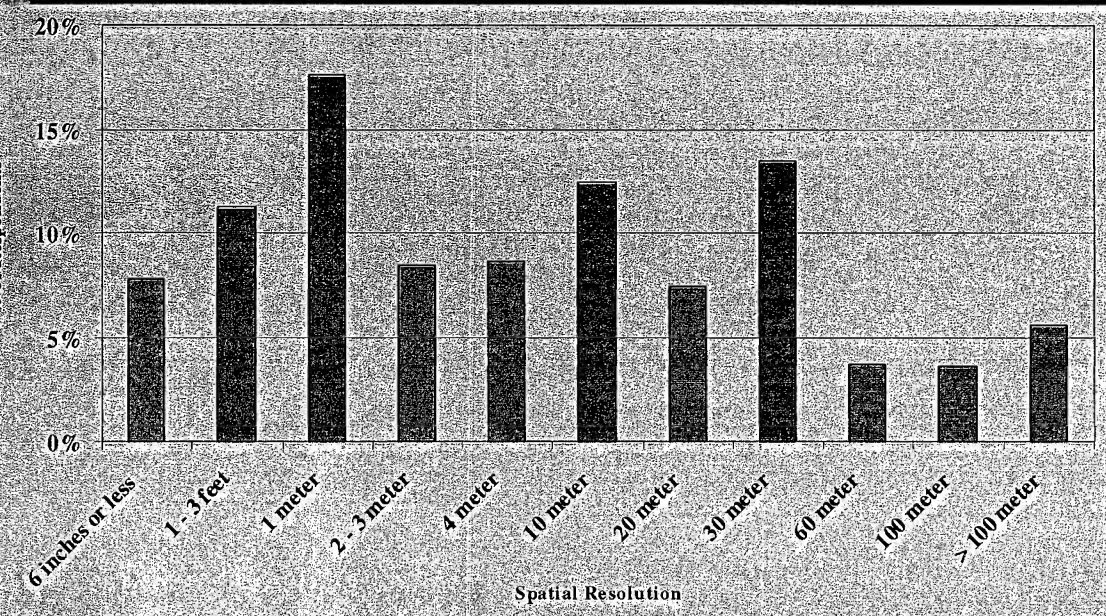
Application Areas In Which Government Respondents Work



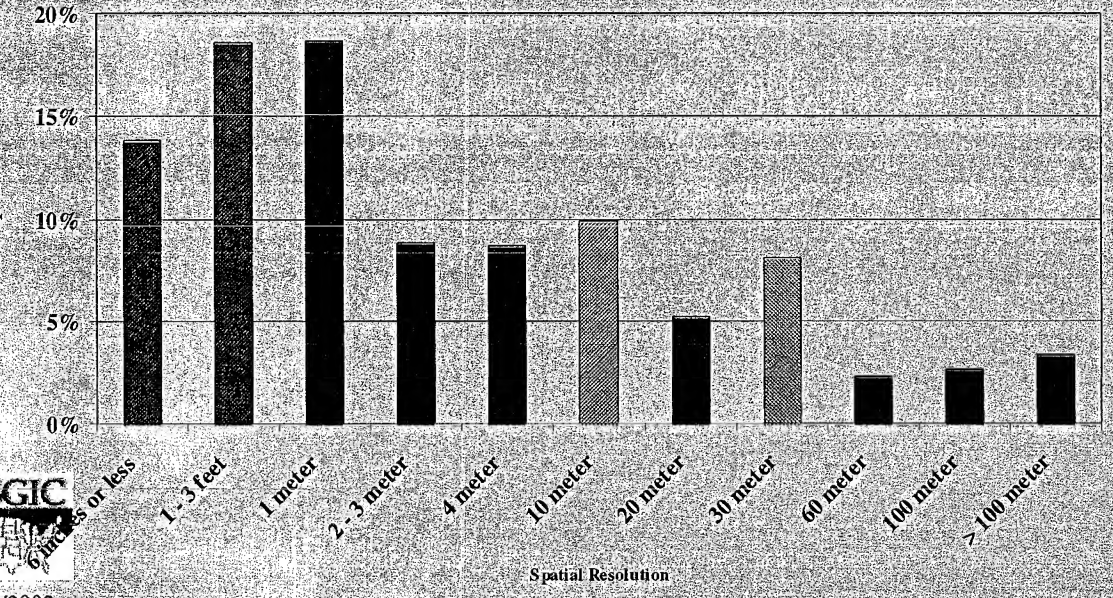
About 55% of the Government Sector workforce is involved in General Mapping, Environment, Civil Government Application Areas.

- ✓ Spatial Resolution
- ✓ Geo-location Accuracy
- ✓ Data Layers
- ✓ Elevation Accuracy
- ✓ Image Types
- ✓ Area Coverage
- ✓ Timeliness

Spatial Resolution: Use vs. Need (All Sectors)



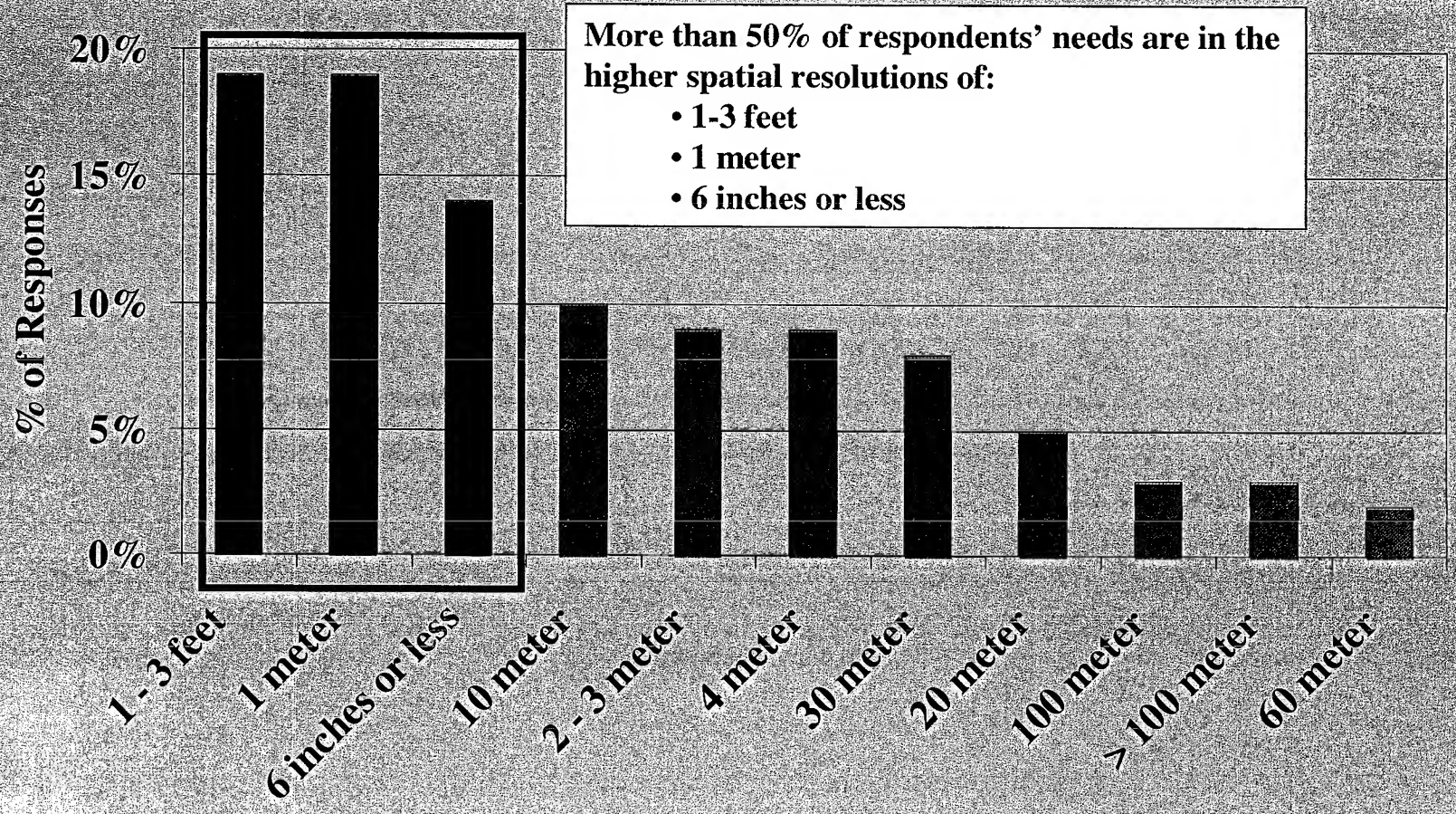
Currently, 1 foot to 1 meter; 10 meter; and 30 meter spatial resolutions are the most used



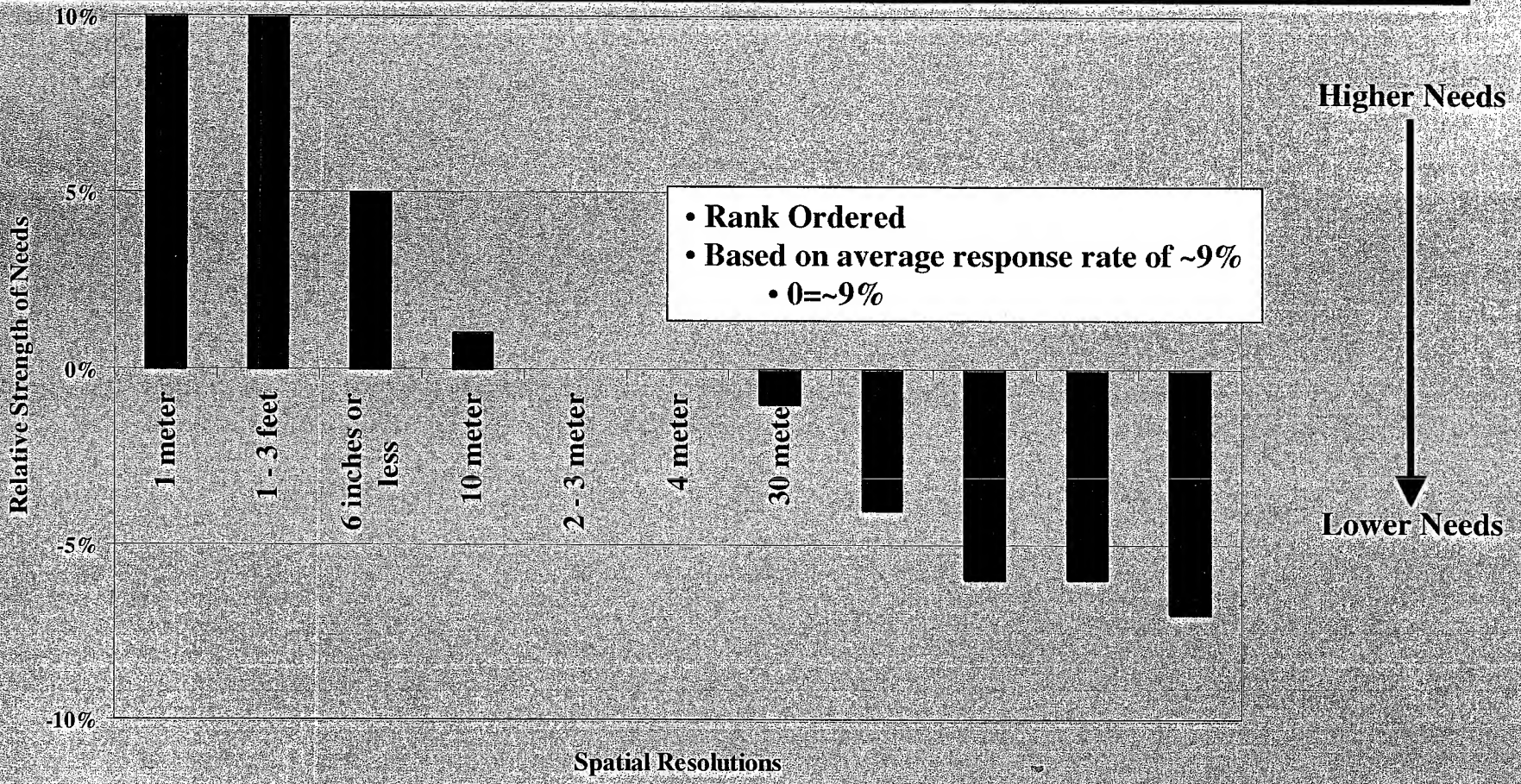
There is a definite shift toward higher spatial resolution, especially to meet needs at the 3-foot and less levels

Spatial Resolution Need (All Sectors)

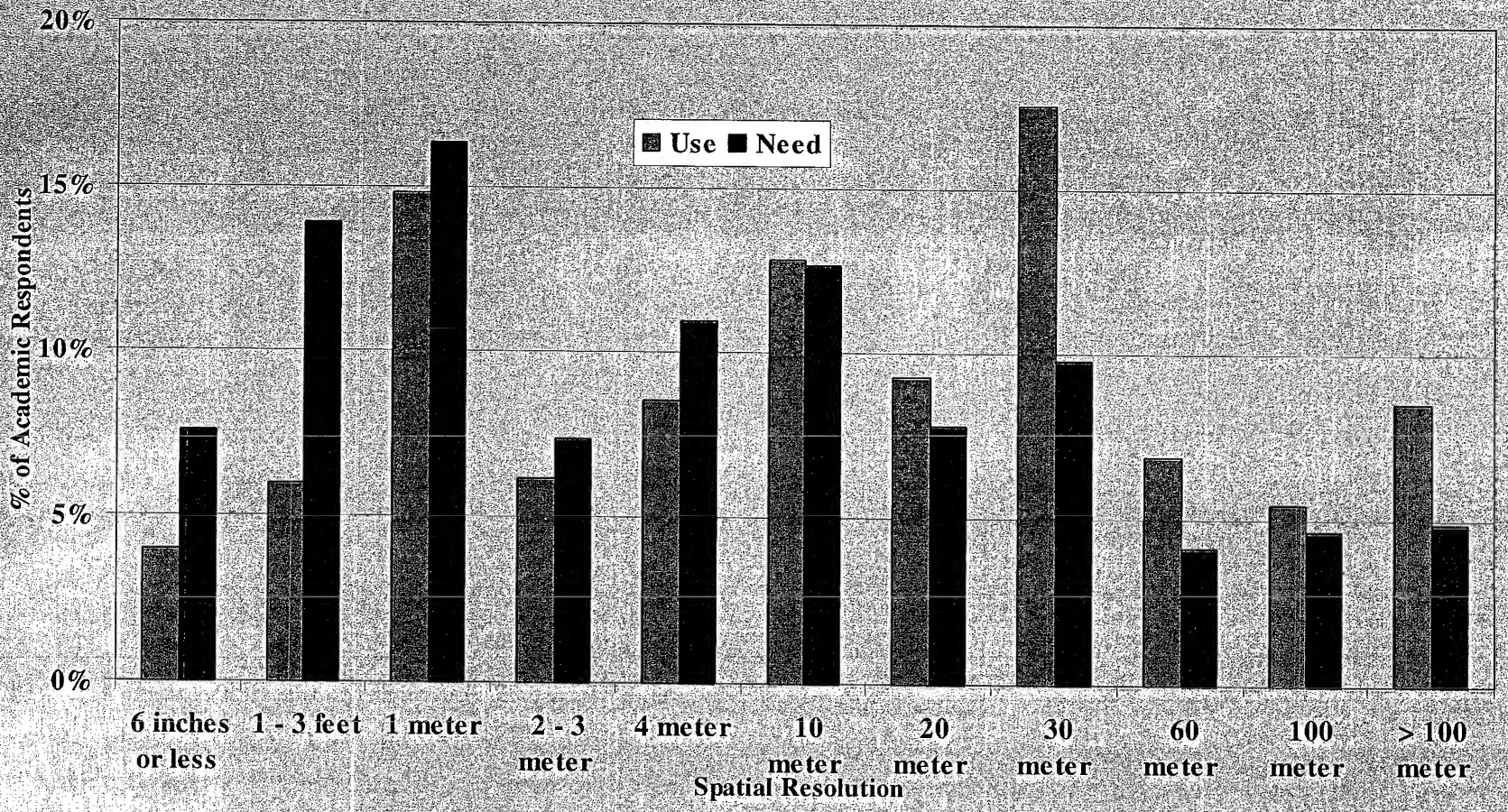
Rank Ordered by % of Responses



Relative Spatial Resolution Needs (All Sectors)

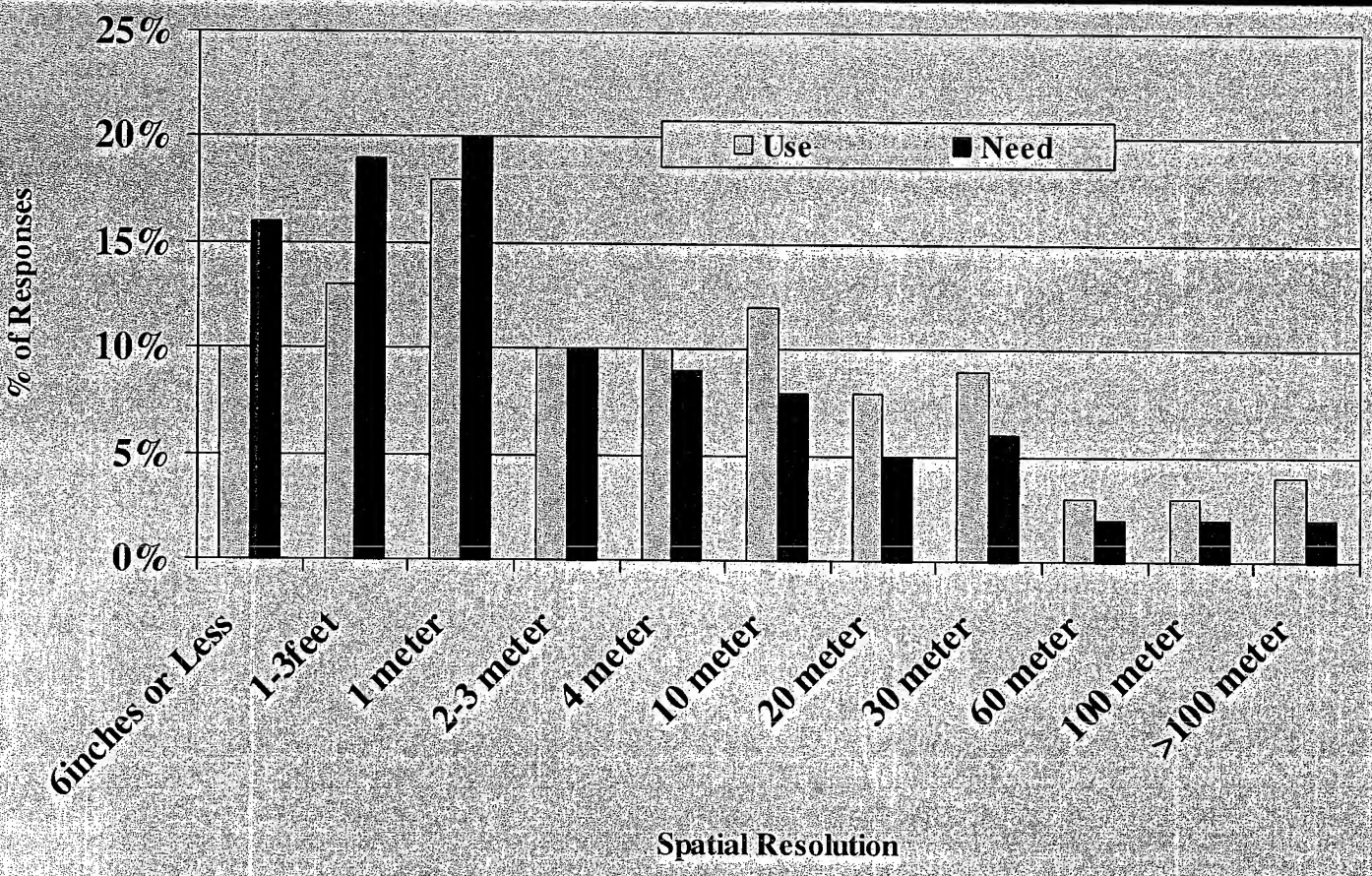


Spatial Resolution Use Vs. Needs : Academic



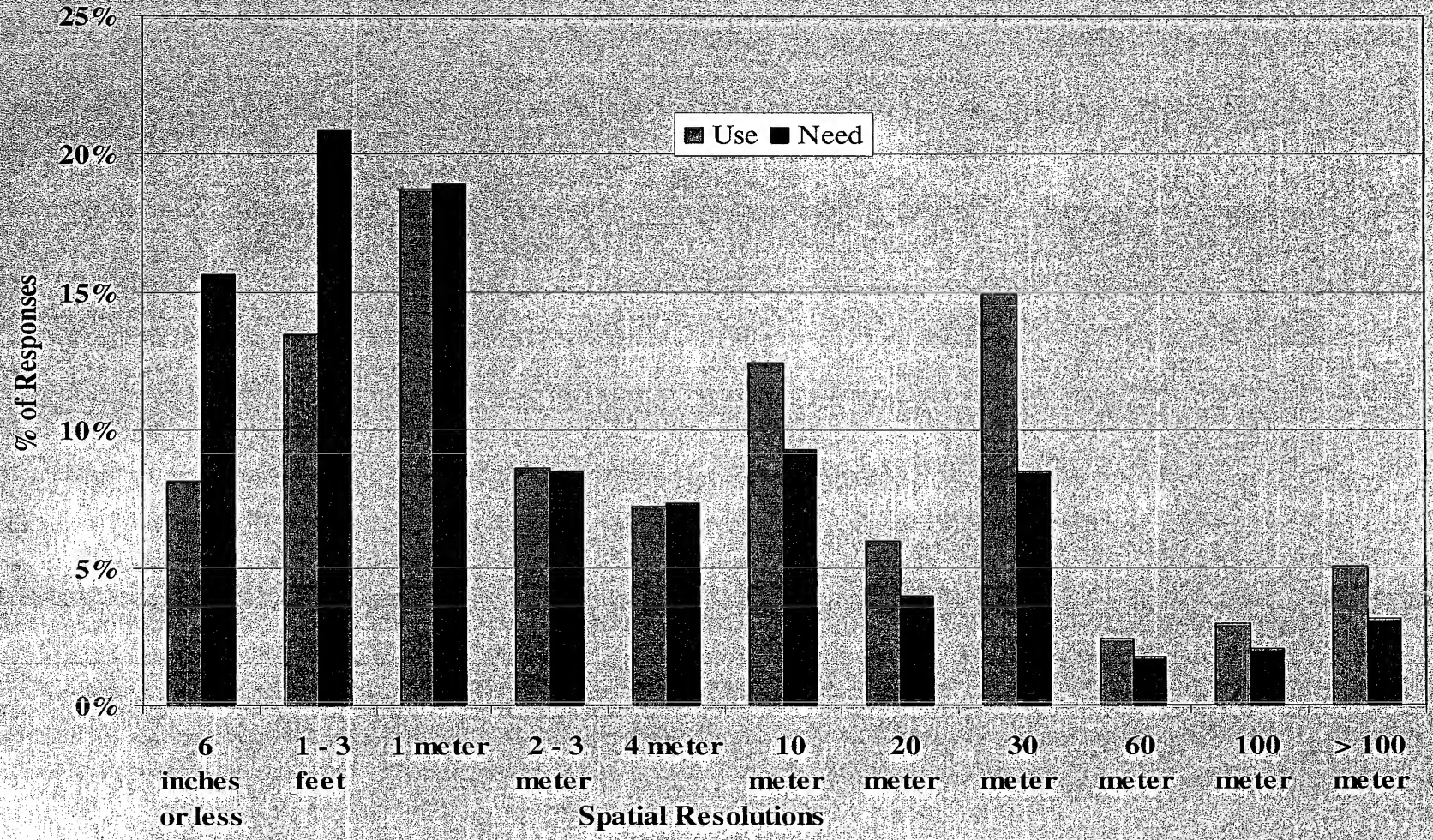
The Academic Sector shows fairly strong needs in the 1-3 feet and 6 inches or less resolutions and a lesser needs at 30 meters and less levels

Spatial Resolution Use Vs. Needs : Commercial



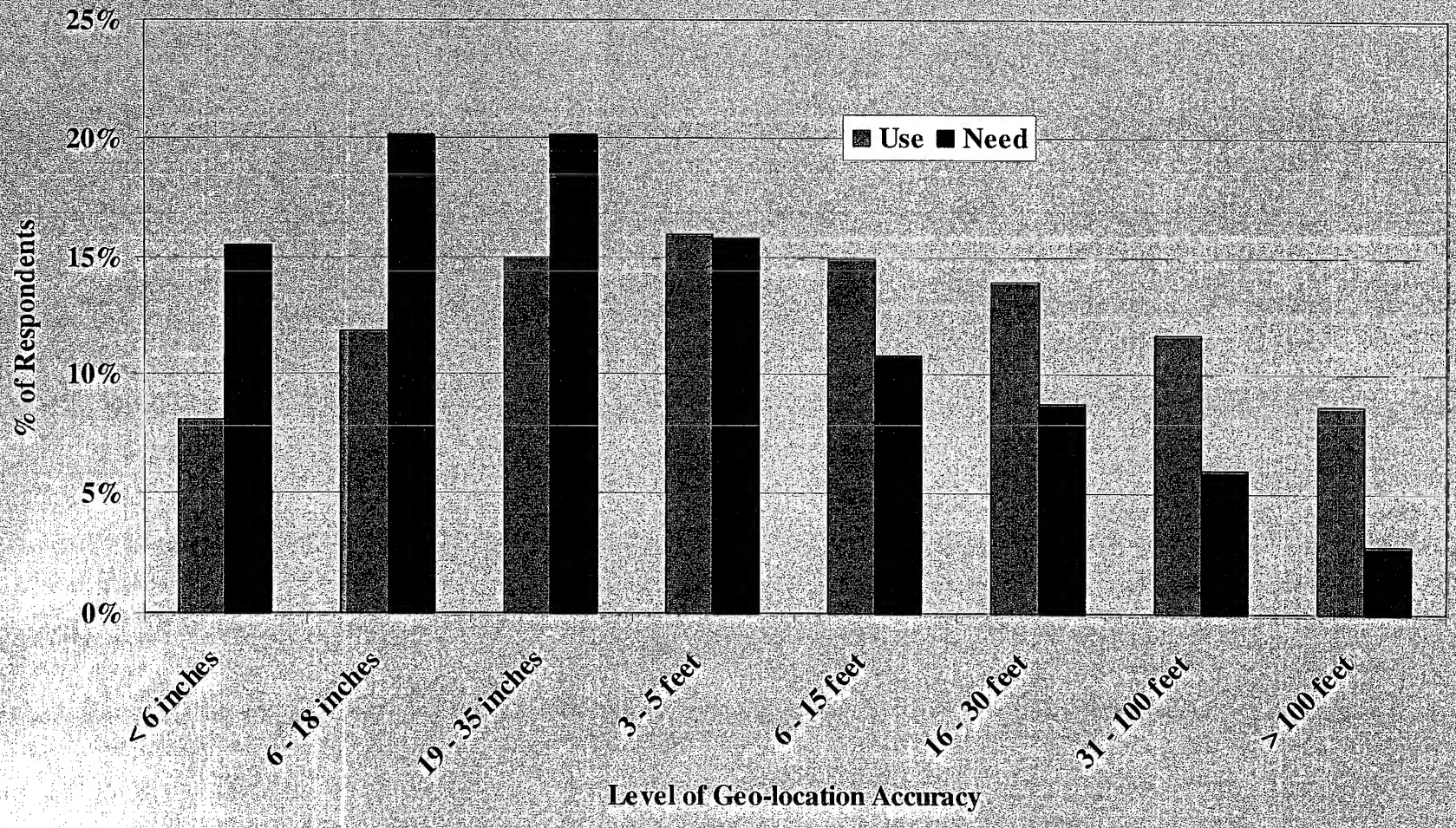
Commercial use and needs tend toward higher resolutions (especially 1 meter and higher), probably due to less price sensitivity than Government or Academic Sectors

Spatial Resolution Use Vs. Needs: Government



Government needs are shifting to the higher spatial resolutions

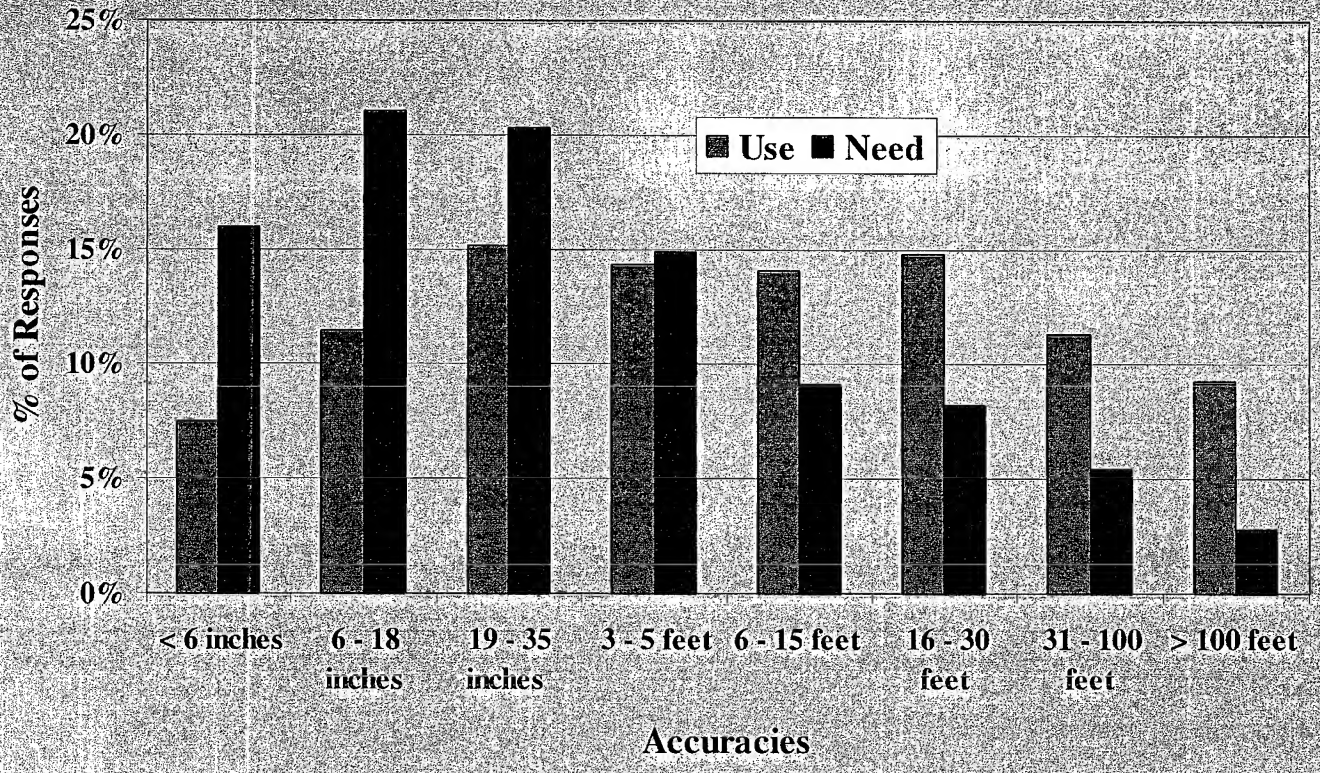
Geo-location Accuracy Use Vs. Needs: All Sectors



- There is a mismatch between Geo-location accuracies in Use vs. Needs

Based on Phase II 1501 Survey Use responses and 1153 Need responses

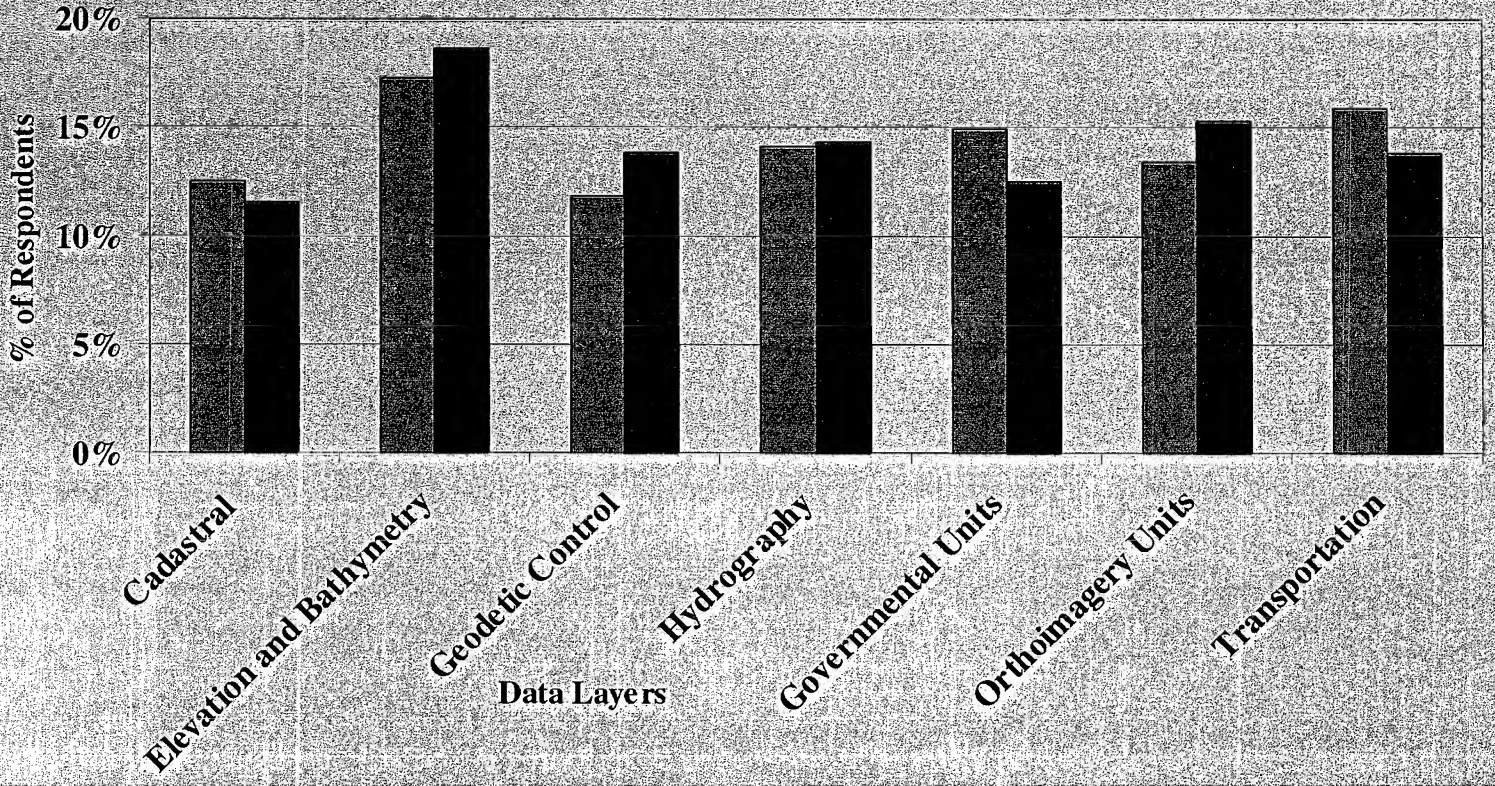
Geo-location Accuracy: Government



The Government Sector has pronounced needs for Geo-location accuracies at levels less than 3 feet

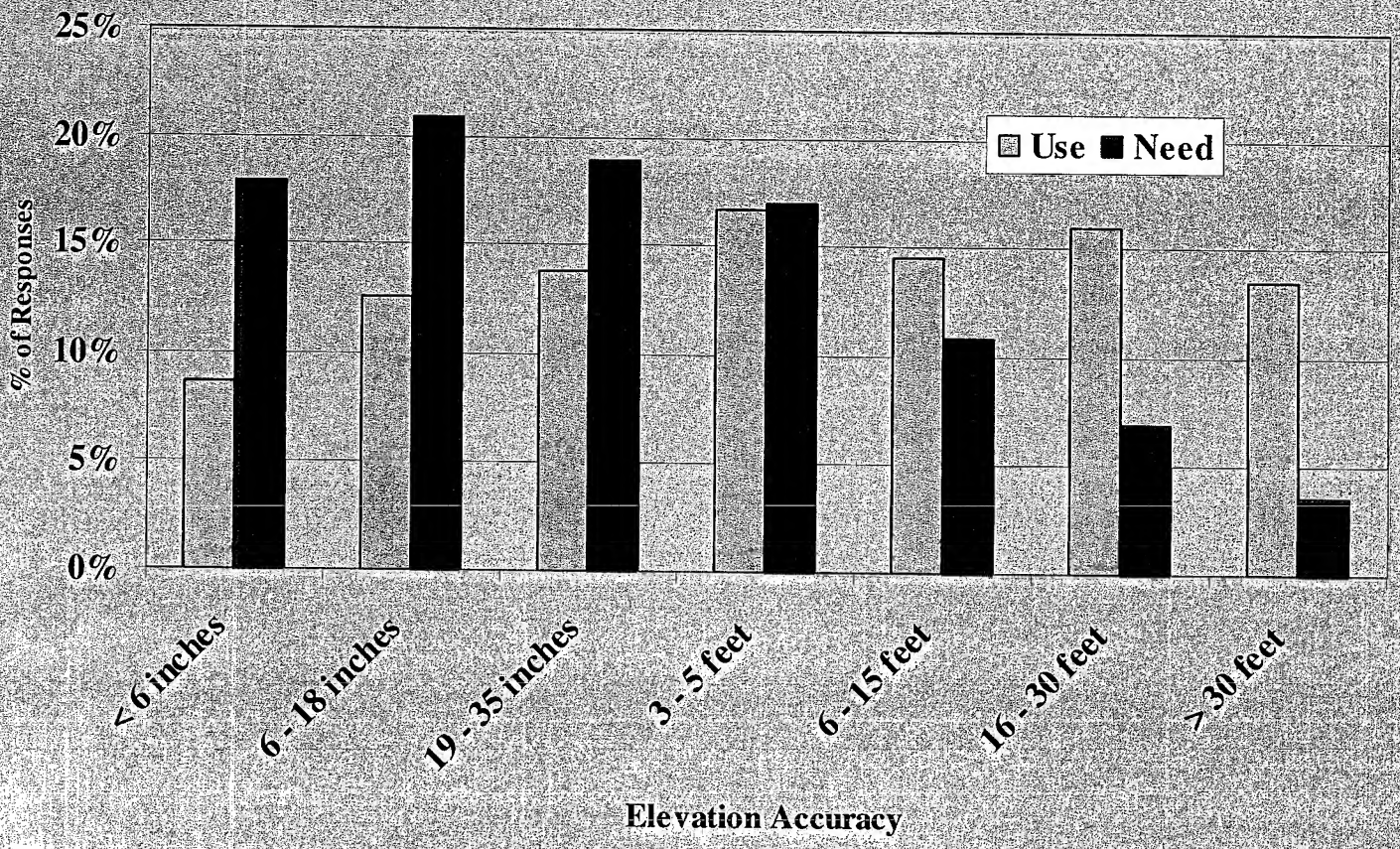
Responses: 647 Use; 537 Need

Data Layers: Use Vs. Need All Sectors



- Sectors tend to use and need the data layers in similar proportions
- Elevation/Bathymetry and Orthoimagery Units are most used and most needed
- Cadastral is least used and needed

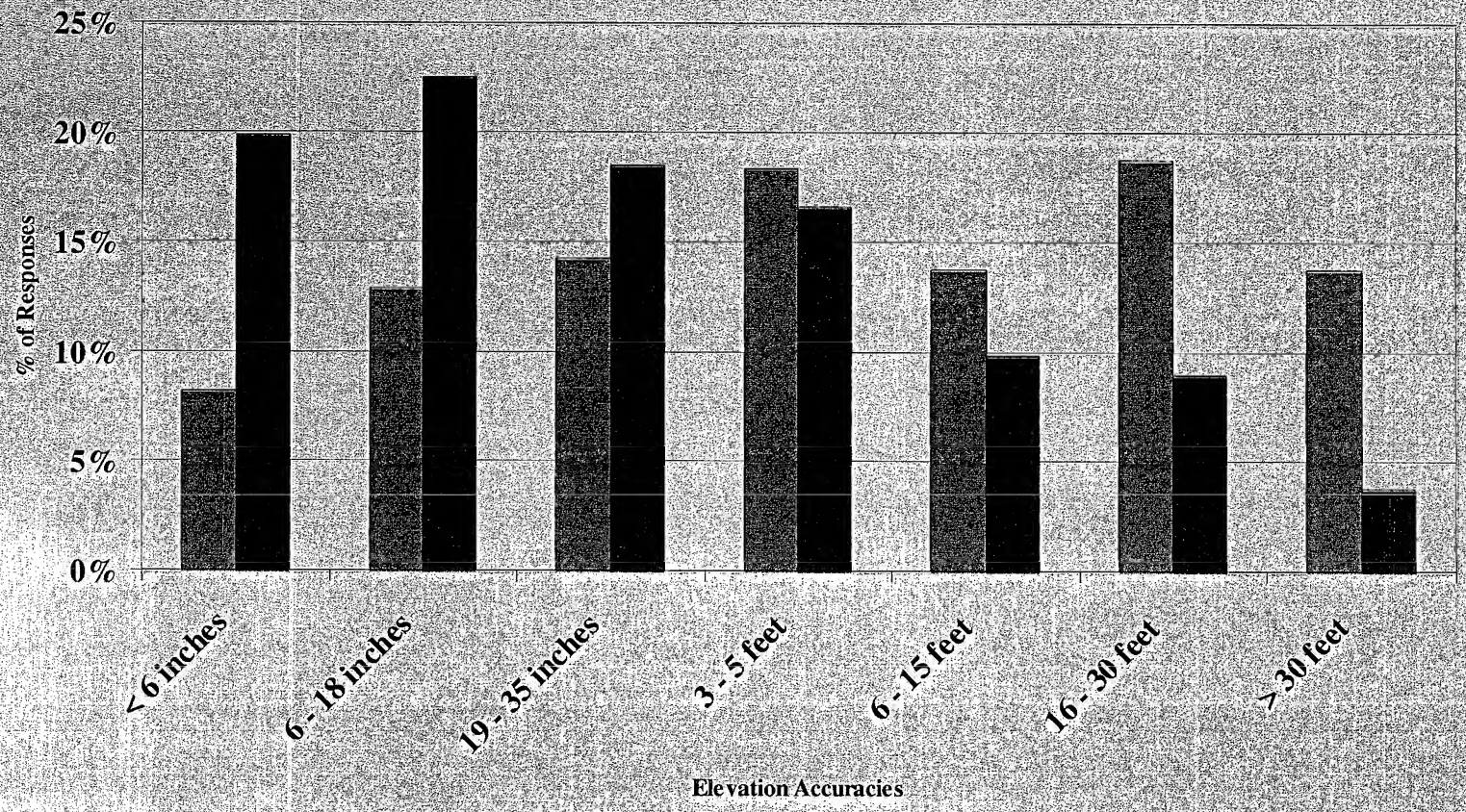
Elevation Accuracy: Use vs. Need (All Sectors)



- There is a major mismatch in elevation accuracies in Use vs. Needs
- About 60% of the need is at elevation accuracies of less than 3 feet

Based on Phase II 1050 Survey Use responses and 968 Need responses

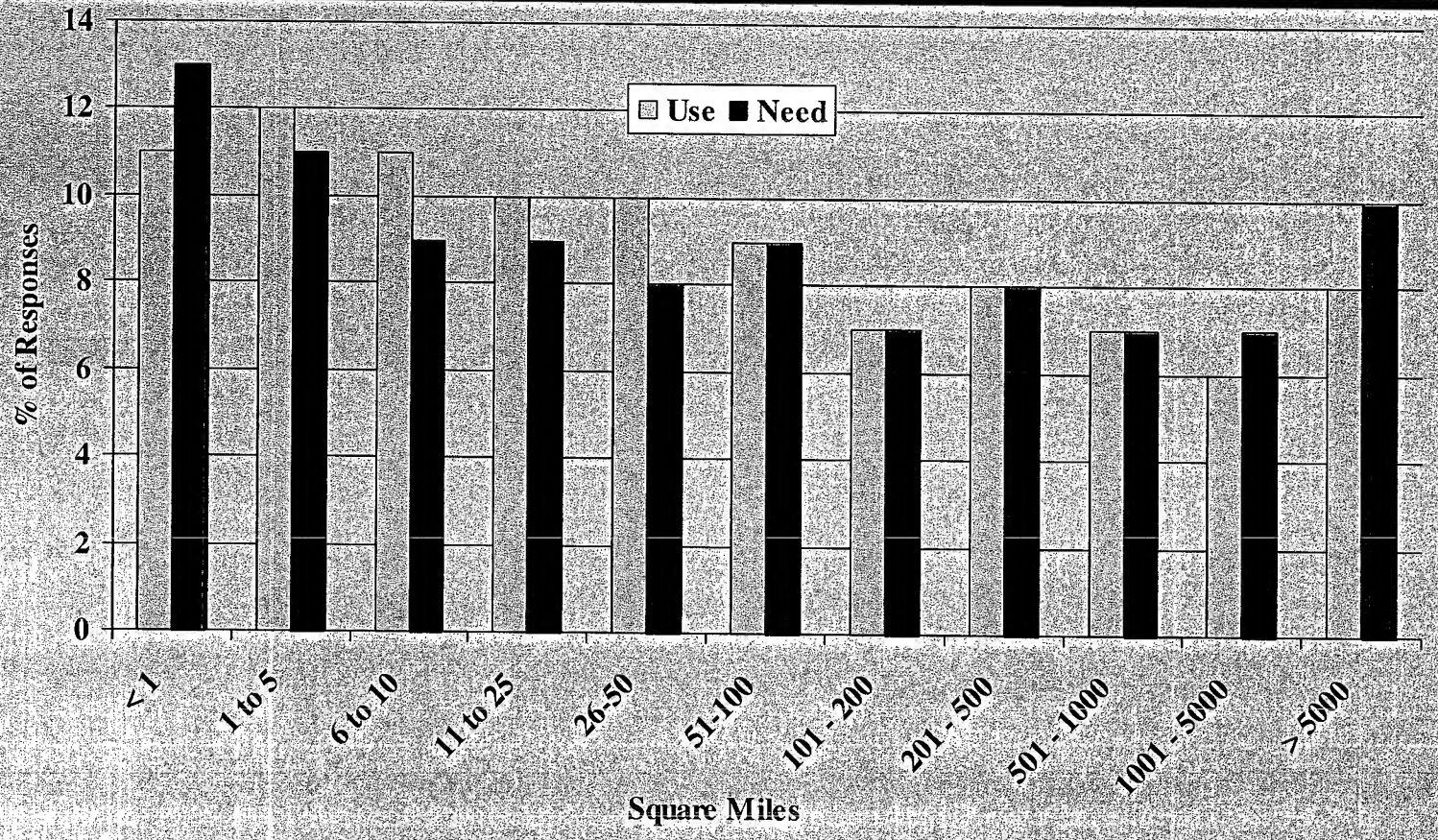
Elevation Accuracy Use vs. Need: Government Sector



A large gap between what is being used vs. what is needed occurs in the 18 inches and less regimes

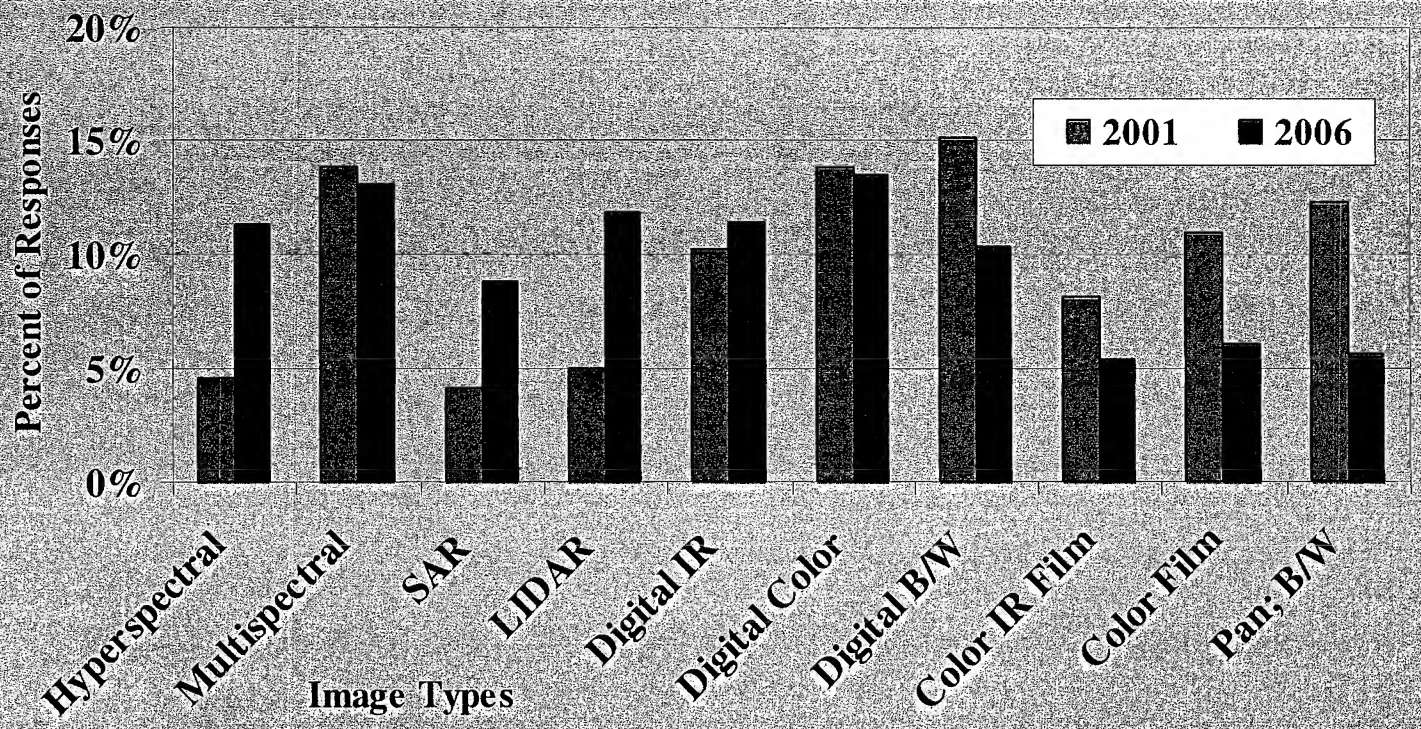
Responses: 467 Use; 445 Need

Area Coverage: Use versus Need (All Sectors)



- Area Coverage use and needs are fairly well aligned
- There appear to be some unmet needs at the extremes (<1 Sq. Mi. and >5000 Sq. Mi.)

Use of Image Types: 2001 vs. 2006 (All Sectors)



Most used in 2001 (>10%)

1. Digital B/W
2. Multispectral
3. Digital Color
4. Pan Film (Pan; B/W)
5. Color Film
6. Digital IR

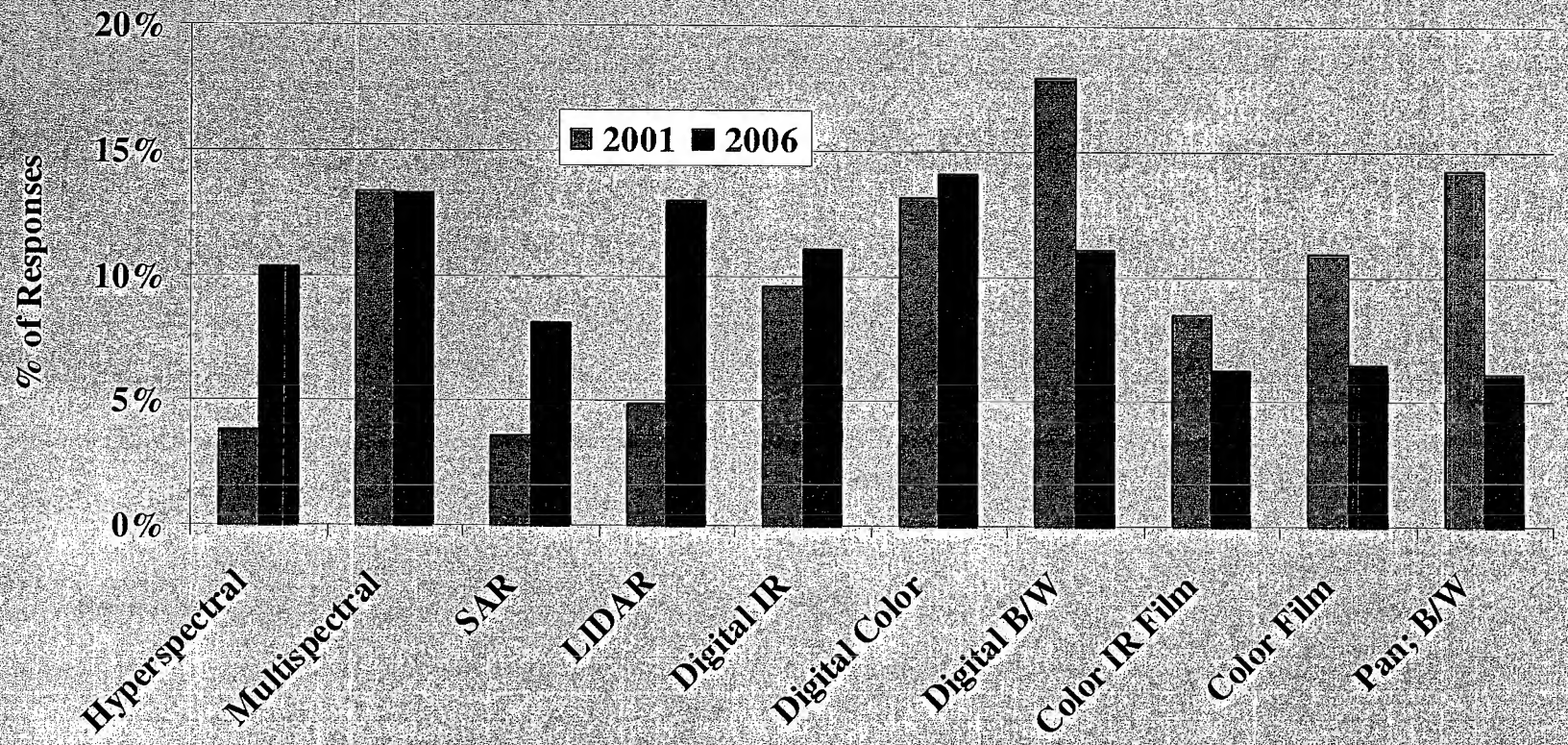
Most in use in 2006 (>10%)

1. Multispectral
2. Digital Color
3. LIDAR
4. Digital IR
5. Digital B/W
6. Hyperspectral

We believe "Digital" includes digital capture and analog scanned products

Based on Phase II 2796 (Year 2001) Survey Responses and 2948 (Year 2006) responses

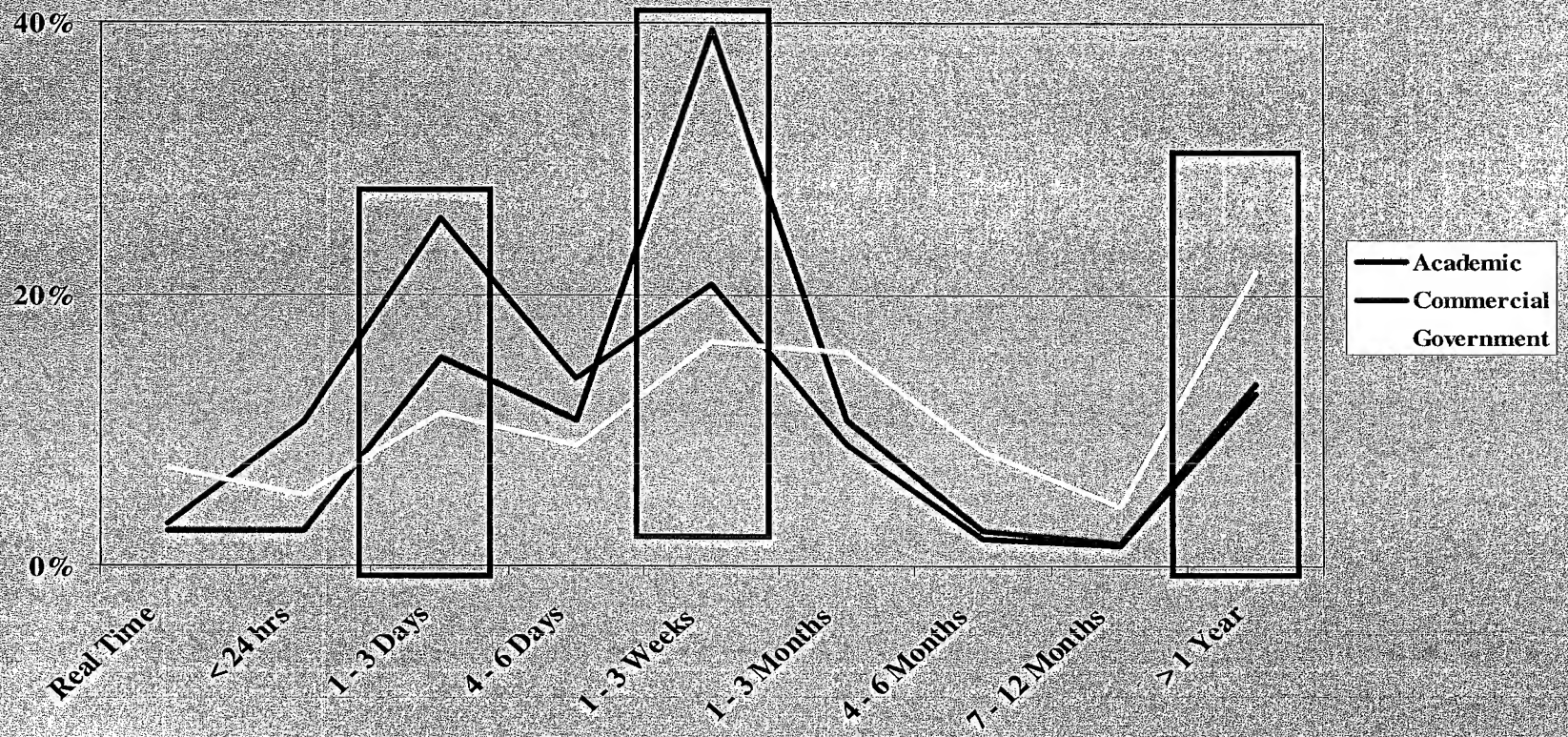
Use of Image Types 2001 vs. 2006: Government Sector



- Biggest increases: Hyperspectral, SAR, and LIDAR
- Biggest decreases: Pan B/W; Color Film; Color IR Film; Digital B/W

Responses: 1124 (2001) 1231 (2006)

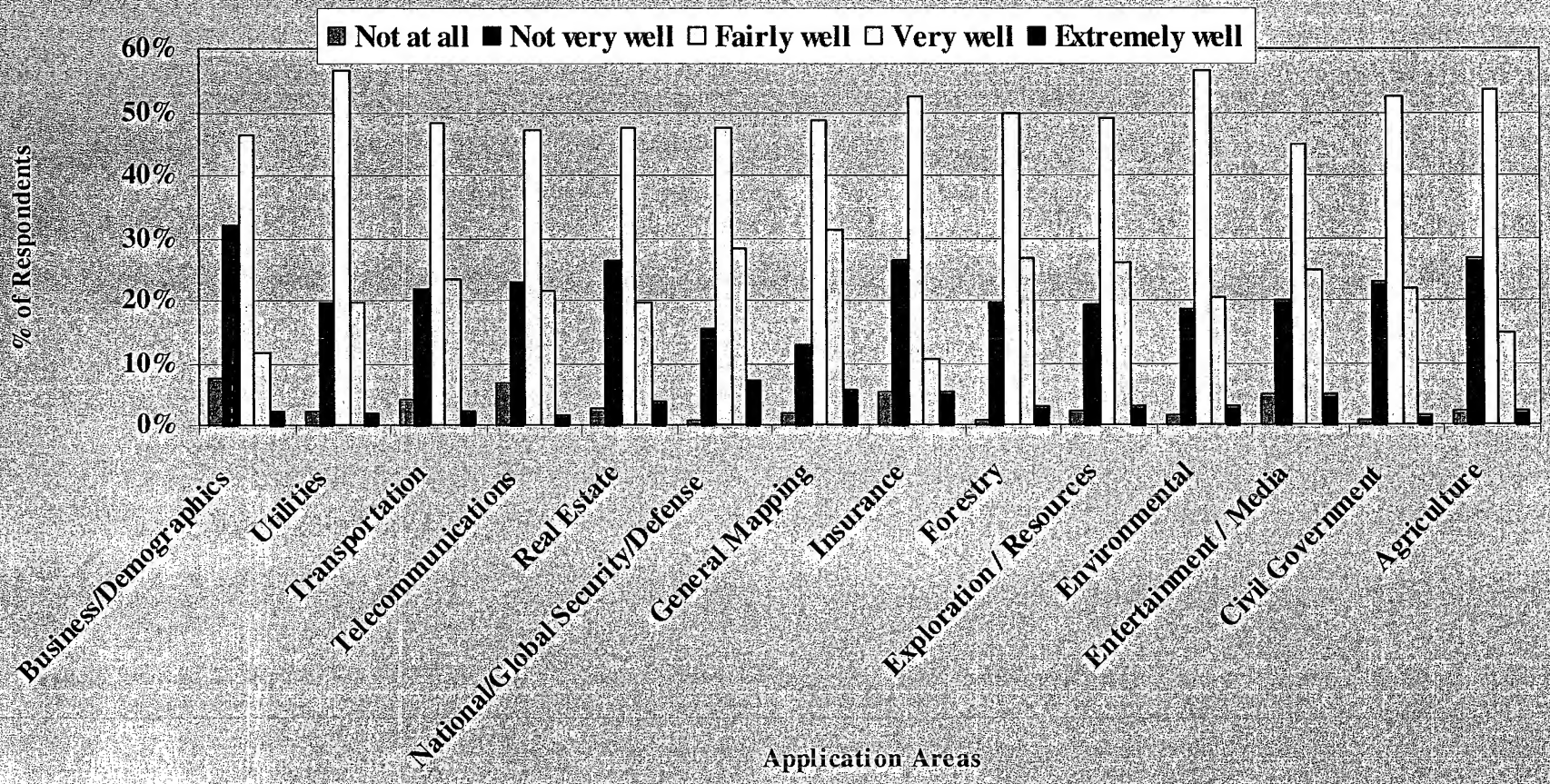
Timeliness Requirements



- Government Sector has more interest in "Real Time" range than other Sectors
- Nearly 60% of Commercial Sector interest centers on the "1-3 Days" and "1-3 Weeks" ranges
- All Sectors show high interest in the "1-3 Weeks" range
- Timeliness requirements mirror from sector to sector and cluster around the "1 – 3 Day"; "1-3 Week".
- For a large % of the Government Sector timeliness is not an issue

Based on Phase II 545 Survey Responses: Academic 111, Commercial 187, Government 247

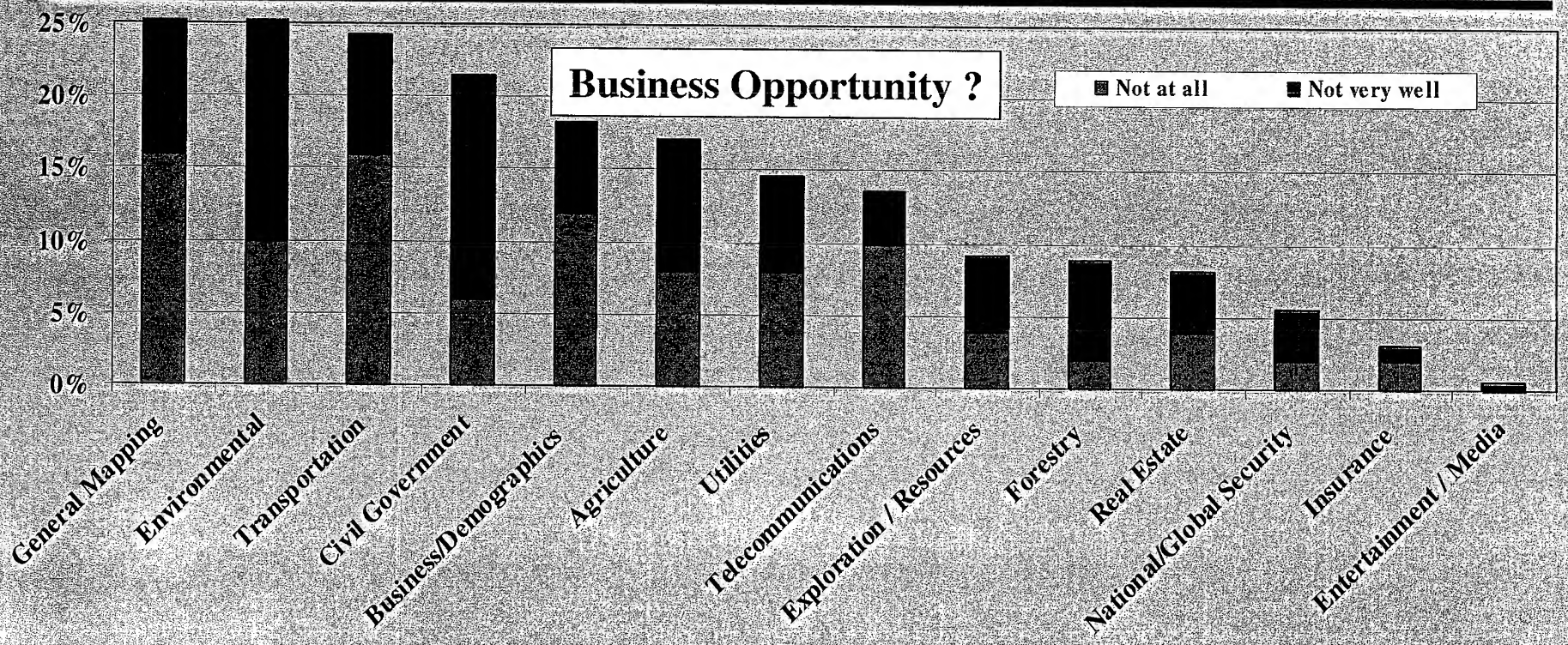
All Sectors – How well are your needs being met by Application Area?



- The majority of needs are met "fairly well" or better
- Approximately 25% are met "not very well" or "not at all"
  - ➢ A potential business development opportunity to grow from "fairly" to "very-extremely well"

Based on Phase II 2456 Survey Responses: Not at all 55, Not very well 486, Fairly well 1258, Very well 574, Extremely well 83

How well are your needs being met in the following Application Areas?



Phase I Most Active Markets
- General Mapping
- Environmental
- Civil Government
- National/Global Security
- Transportation

Phase II Where Most People Work
- Mapping & Geography
- Environmental
- Civil Government
- Transportation

CEO/CFO Most Revenue
- National/Global Security
- Mapping
- Civil Government
- Transportation
- Environmental
- Utilities

Based on Phase II 2422 Survey Responses: Not at all 50, Not very well 482, Fairly well 1239, Very well 569, Extremely well 82

Importance of DIS Characteristics

Interview

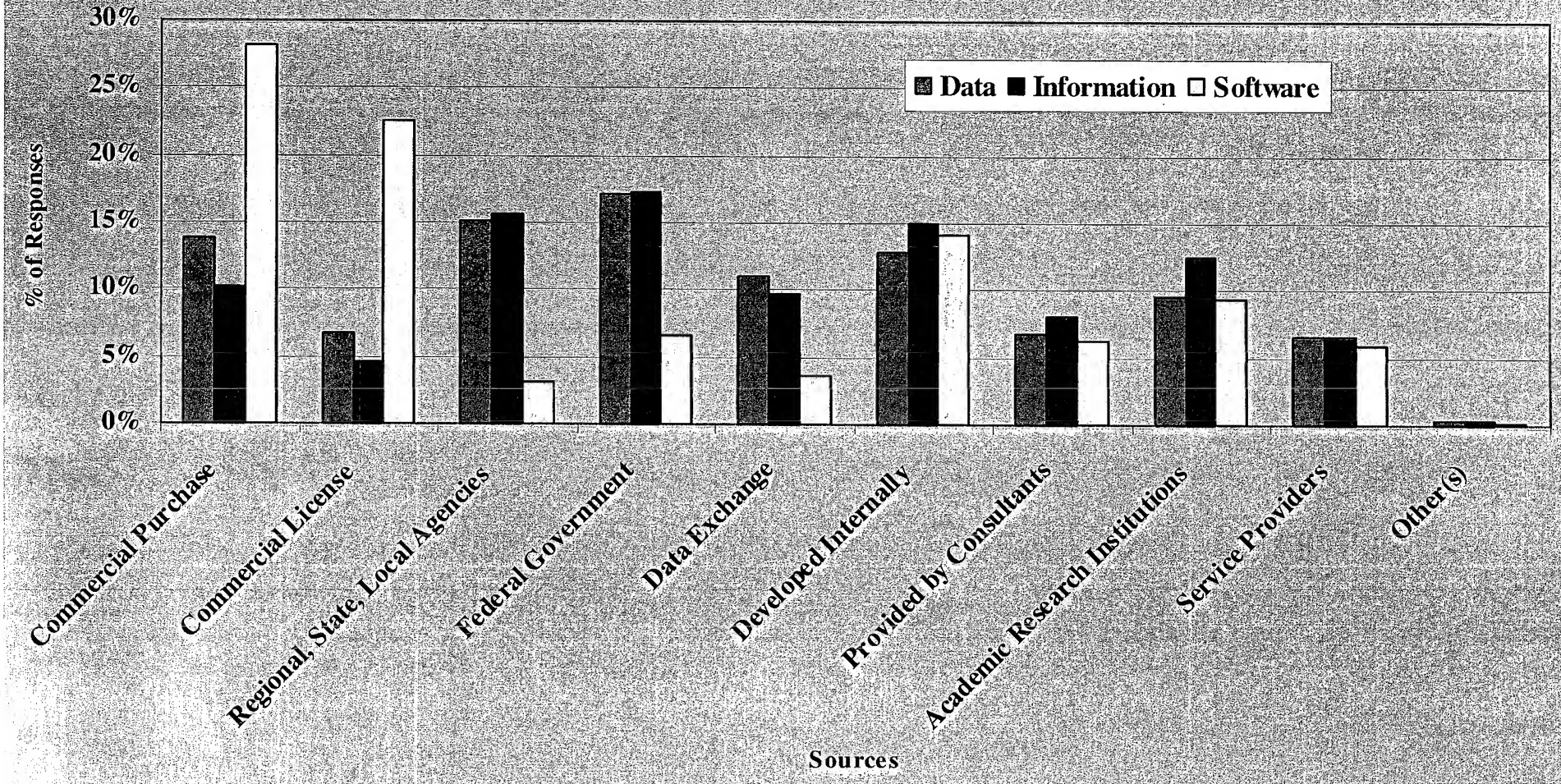
Characteristics	Important	Most Important
Geo-Location Accuracy	76	41
Spatial Resolution	76	40
Cost	34	4
Currentness/Timeliness of Data Delivery	27	7
Color/Spectral/Radiometric Quality	23	9
Ease of Use	23	
Software Utility Compatibility	18	1
Data Format	16	
Area Coverage/Theme Size	15	1

- ✓ Spatial Resolution and Geo-location Accuracy are the most important characteristics
- ✓ Cost is an important characteristic but not most important to this *interview sample*. … HOWEVER, *survey sample* indicates that cost is a major driver for purchasers of data/information

Survey

	More Important	Less Important
Academic	•Spatial Resolution •Cost •Color & Quality •Currentness •Geo-location Accuracy	•Timeliness •Revisit Rate
Commercial	•Geo-location Accuracy •Currentness •Cost •Spatial Resolution •Ease of Use	•Revisit Rate •Documentation
Government	•Currentness •Cost •Geo-location Accuracy •Accuracy Statement •Spatial Resolution •Documentation •Area Coverage	•Revisit Rate

% Reliance on Sources of Data, Information, Software (DIS)



Based on Phase II 6382Survey Responses: Data 2826, Information 2367, Software 1189

DIS Providers

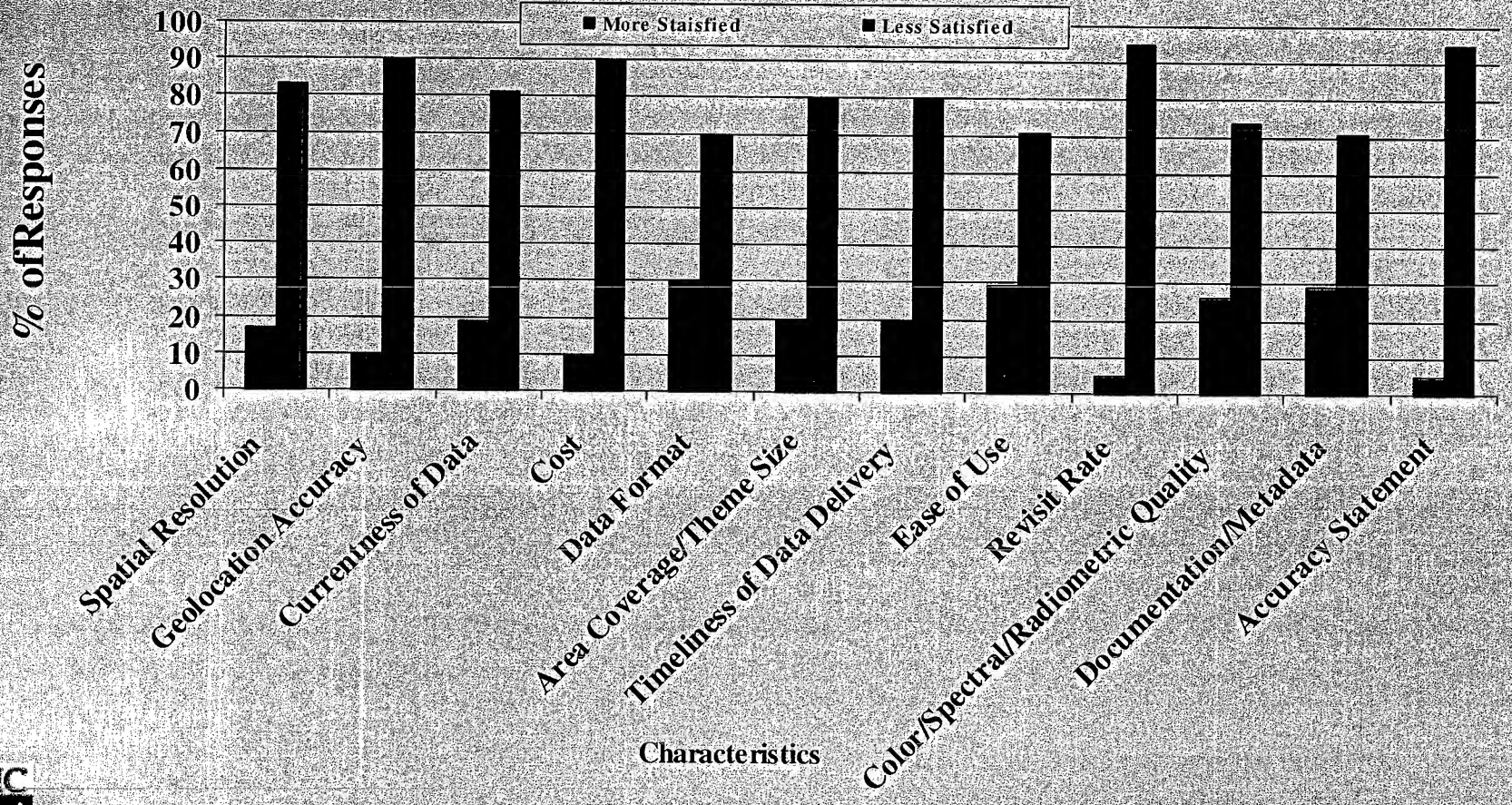
- ✓ Assume following "Provider Groups"
  - Private: Commercial Purchase & License; Consultants; Service Providers
  - Public: Federal; Regional, State, Local, Tribal
  - Academic Research
- ✓ Then, how much DIS product does each "Provider Group" send to the marketplace?

	Products to Marketplace		
Provider Groups	Data	Information	Software
• Private	30%-35%	25%-30%	60%-65%
• Public	30%-35%	30-%-35%	~10%
• Acad. Research	~10%	10%-15%	5%-10%
Totals*	70%-80%	65%-80%	75%-85%

* Other "Providers": Data Exchange (~5%-10%); Internal Development (~15%)

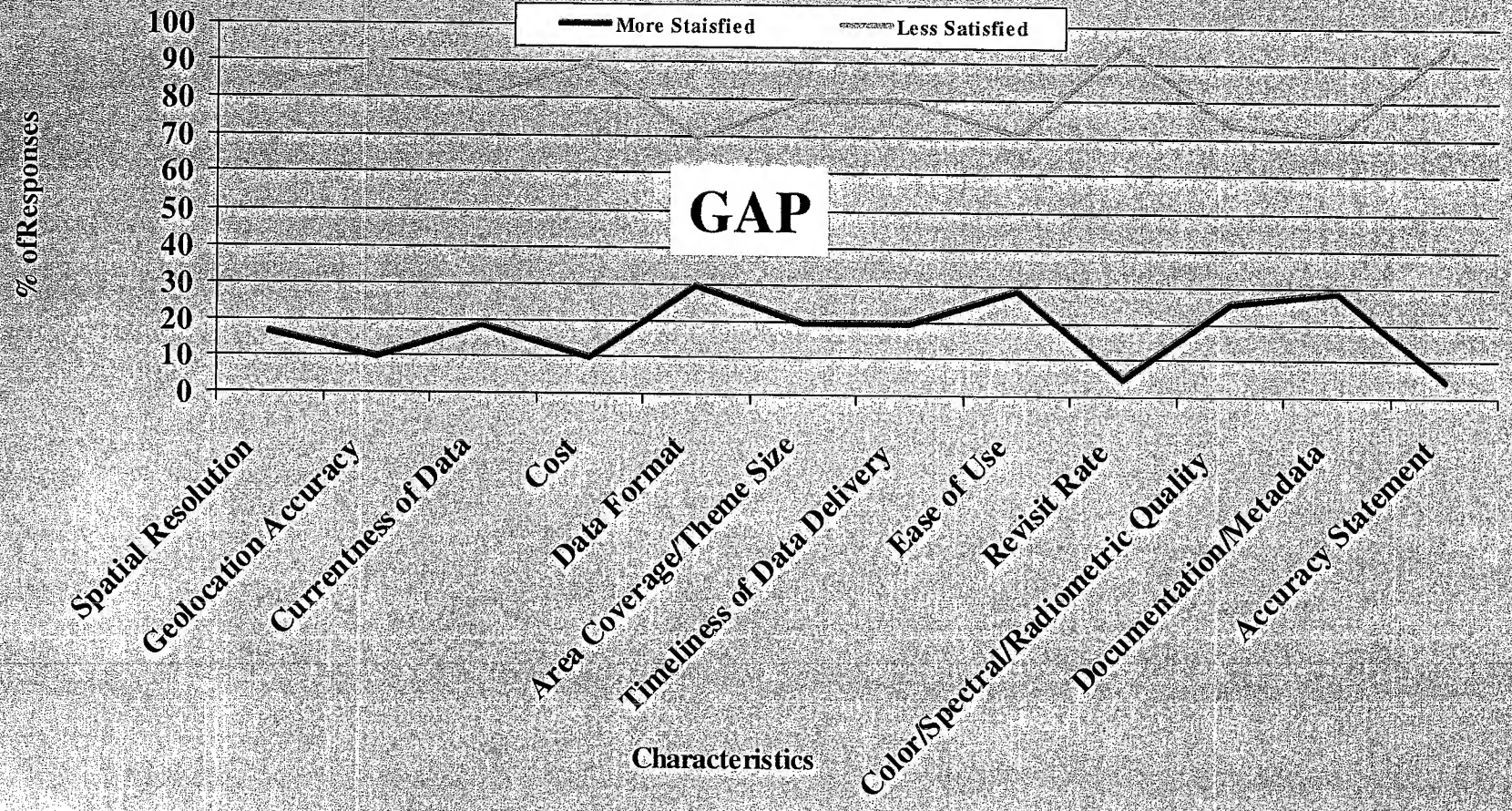
Satisfaction with *Important* D/I/S Characteristics: All Sectors

- Assume the "Very Satisfied" and "Extremely Satisfied" dimensions are in the same grouping and call that Grouping *More Satisfied*
- Make a similar assumption re: "Somewhat Satisfied" and "Satisfied" and they can be referred to as *Less Satisfied*.



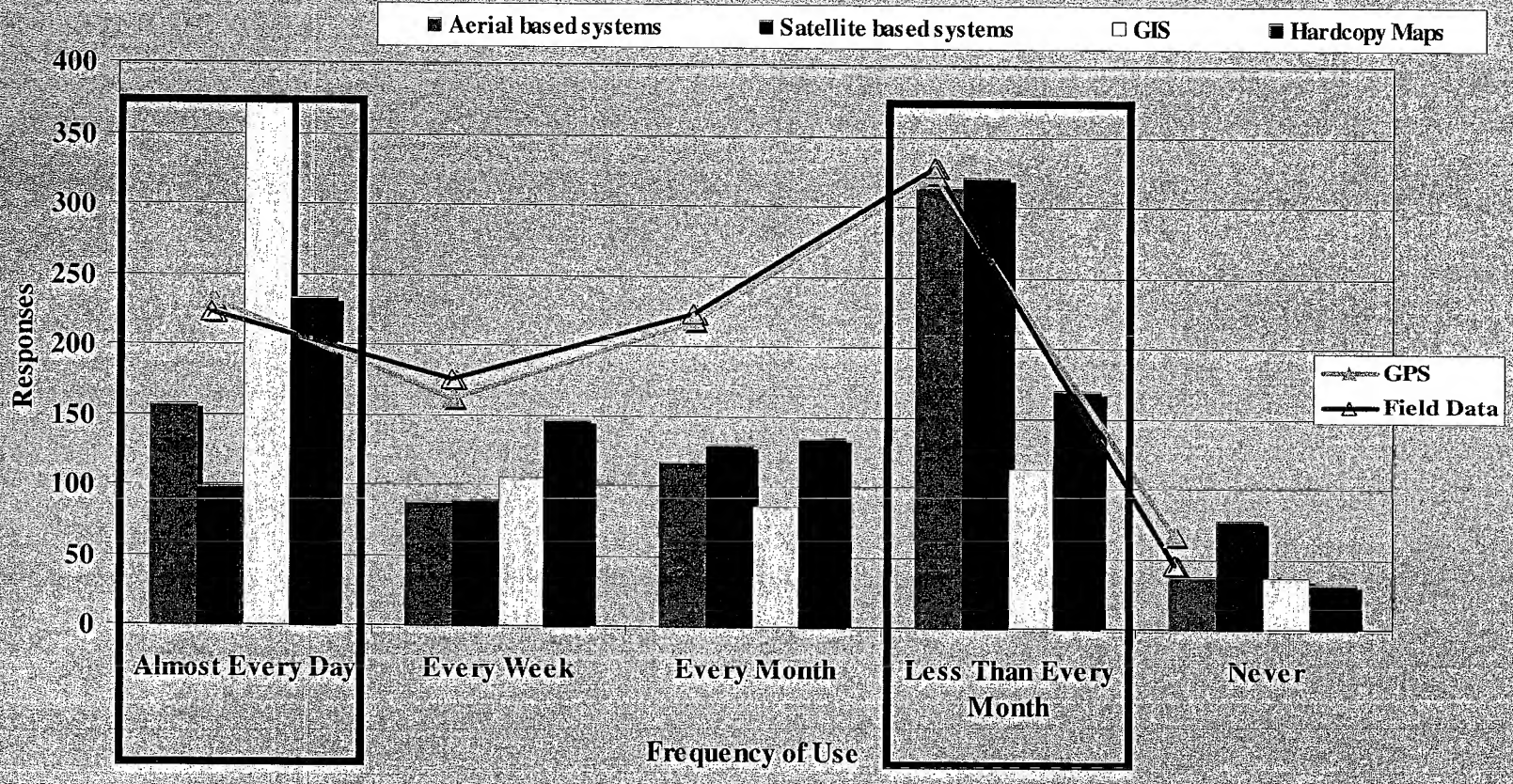
Apparently, there is room for improvement in "Satisfaction"

Satisfaction with *Important* D/I/S Characteristics: All Sectors



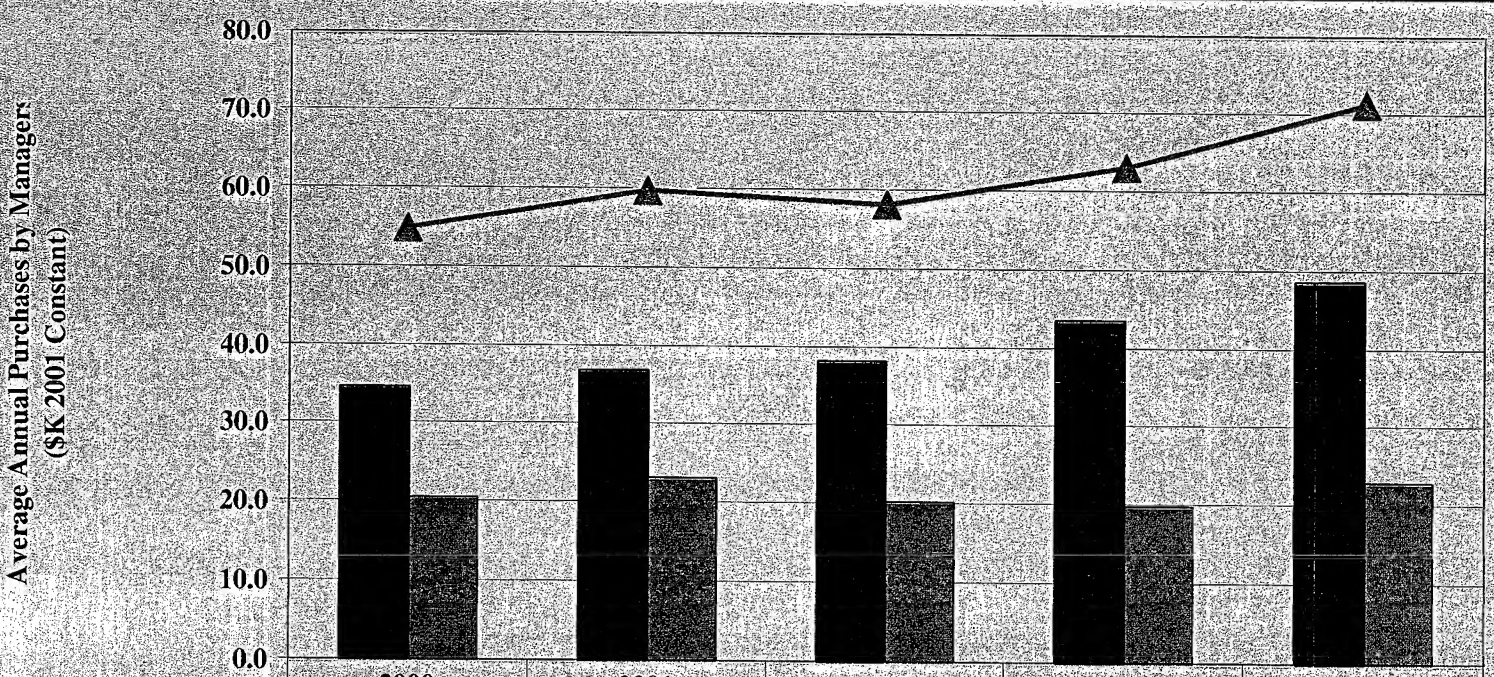
This presents potential business opportunities

How Often Data/Information by General Type is Used: All Sectors



- GIS And Hardcopy Maps are most often Used "Almost Every Day"; Satellite-based System Data / Information least
- The Bi-modality indicates some tools are frequently Used "Almost Every Day" others "Less Than Every Month
- There may be a relationship between frequency of Use and frequency of up-dates required

Average Annual Purchases of Remote Sensing Data, Information and Software* Made by Managers



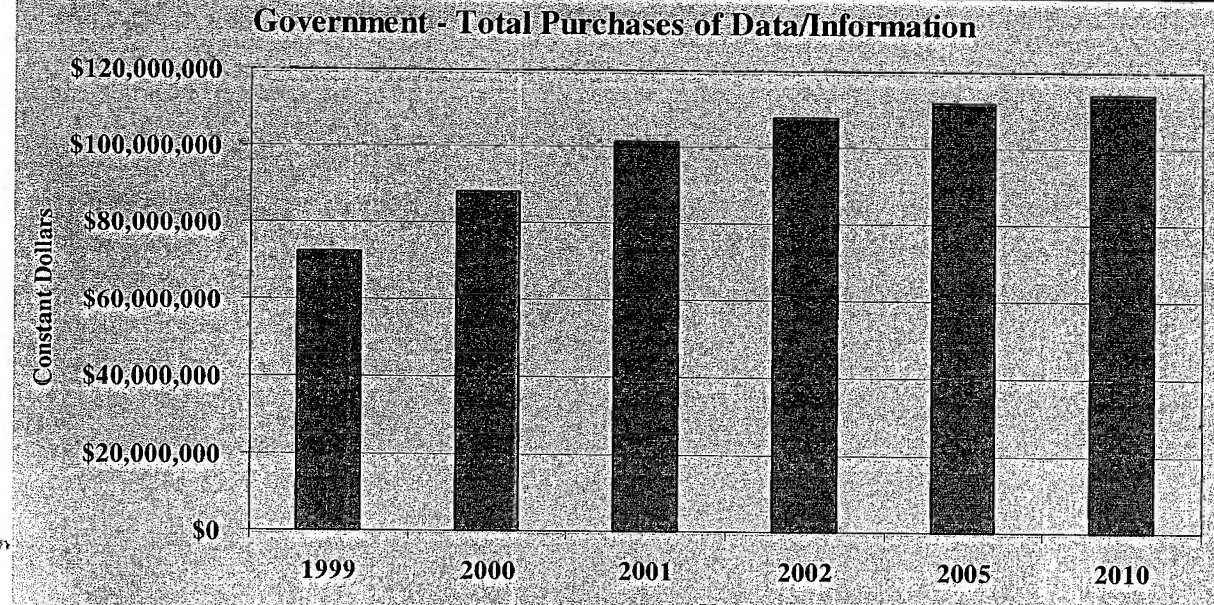
	2000	2001	2002	2005	2010
Data/Information	34.6	36.8	38.1	43.5	48.6
Software	20.4	23.2	20.2	19.8	23.0
Total	55.0	60.0	58.3	63.3	71.6

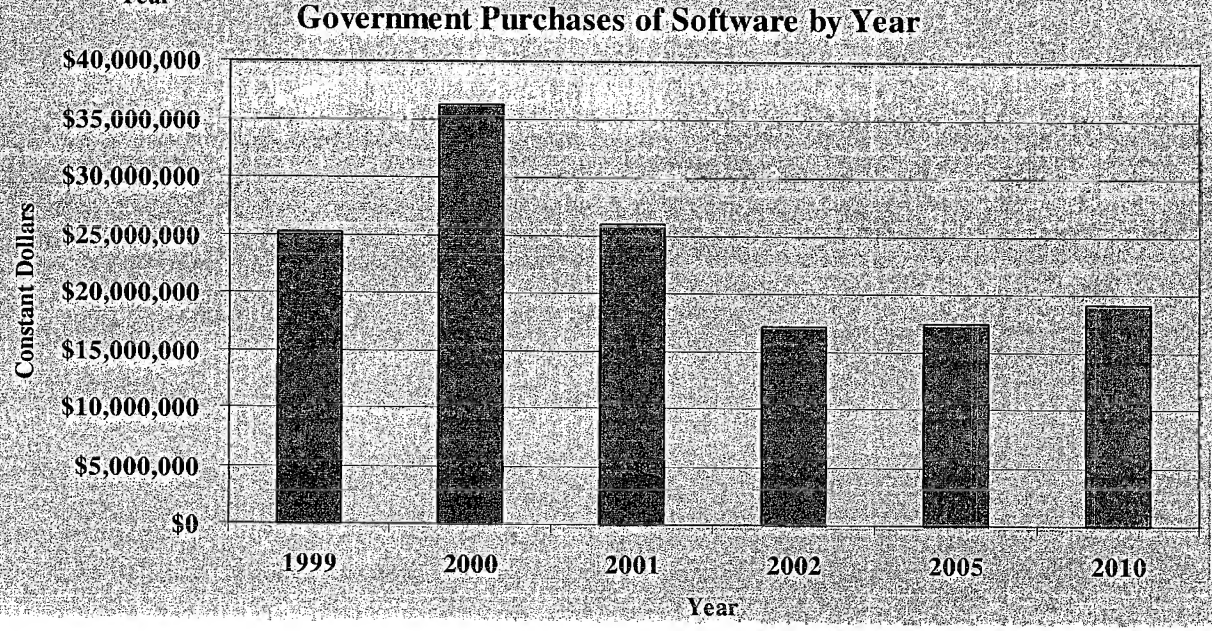
- Data and Information have a combined average annual growth (AAG) rate of approximately 9%
- Software purchases (which tend to be cyclical) fluctuate, however, over the total period 2000 – 2010 software purchases AAG rate is ↑ 4%

Based on Phase II Survey Responses

*Calculated from base year 2000

Government Purchases of D/I/S





Conclusions

- ✓ Our sample is large (>1,400) and the geographic distribution of our sample indicates that the data do not have a regional bias
- ✓ Participants in this analysis have the breadth and scope necessary to enhance its credibility
- ✓ Both Manager and User groups are well represented
- ✓ Data reinforces other estimates of double digit RSI growth into the next decade
- ✓ Current community of managers/users is both well educated and generally knowledgeable remote sensing
  - Very little is done by way of education and training to upgrade the workforce after formal education is completed

Based on Phase II Survey Reponses

Conclusions

- ✓ **The CRSI market is growing at about 10% per year (effects of 9/11/01???)**
  - **About $2B in 2001, growing to about $6.5B in 2012 (Constant CY 2001$)**
  - **Aerial and satellite markets do not seem to be in competition**
- ✓ **The industry is fragmented and primarily populated with small companies**
  - **Average Annual Revenues, CY2001: $3.7M**
  - **Does not necessarily mean low entry barriers.**
- ✓ **Imagery collected from aerial platforms is used 2 times more frequently than imagery collected from space platforms**

Conclusions

- ✓ High Resolution, Geo-location Accuracy, and Cost are market drivers
  - Information value is the key factor
- ✓ Digital is the preferred format
- ✓ Companies operate in more than one business segment
- ✓ Government agencies are the largest potential Customer group (about 67% of revenues through 2006 per F/S)
  - Federal and SLT interests are not the same
  - At SLT level, decisions re: the use of remote sensing products are made by elected officials (not RS/GIS professionals)
- ✓ Growth of the Remote Sensing Industry is *more* dependent on funding, user education (marketing), workforce development, and market awareness than on technology development

Conclusions

- ✓ **Experience of the RSI workforce follows what seems normal trends for other industries.**
  - Persons enter, some stay and the careerists become the largest group after about 9 years
  - Workforce retention is an issue

- ✓ **Currently, *Across All Sectors*, the most Active Markets/Apps/Activities/ Market Segments are:**
  - Mapping/Geography
  - Environment
  - Civil Government
  - National/Global Security (position varies with how you account for Defense programs)
  - Transportation

Opportunities in less developed Market Segments???

Based on Phase II Survey Reponses

Conclusions

- ✓ The public and private sectors provide about the same amount of data and information products to the marketplace; the private sector is the primary provider of software
- ✓ There is a significant gap between *Spatial Resolutions* in use and what is needed. This gap is pronounced at the 1-3 feet and <6-inch levels
- ✓ There is a significant gap between *Elevation Accuracies* in use and what is needed. This gap is significant at the < 6 inch-level and pronounced at the 6-18-inch and 19-35-inch levels
- ✓ There is a significant gap between *Geo-location Accuracies* in use and what is needed. This gap is significant at the < 6 inch-level and pronounced at the 6-18-inch and 19-35-inch levels
- ✓ While Users Needs are "fairly well" met in the Application Areas, the least satisfaction is found in the most active Markets/ Applications (opportunity?)

Conclusions

✓ **The image types in use will shift dramatically between 2001 and 2006**

Most Used in 2001 (>10%)
1. Digital B/W
2. Multispectral
3. Digital Color
4. Pan Film (Pan; B/W)
5. Color Film
6. Digital IR

Most in Use in 2006 (>10%)
1. Digital Color (3)
2. Multispectral(2)
3. LIDAR (8)
4. Digital IR (6)
4. Hyperspectral (9)
6. Digital B/W (1)

It should be noted that

- SAR use more than doubles
- Digital Color & Multispectral do not grow

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